11-6625-3029-14

TM 11-6625-3029-14

TECHNICAL MANUAL

OPERATOR'S, ORGANIZATIONAL, DIRECT SUPPORT, AND GENERAL SUPPORT MAINTENANCE MANUAL FOR SIGNAL GENERATOR SG-1170/U (WAVETEK MODEL 3001) (NSN 6625-01-120-3501)

This copy is a reprint which includes current pages from Changes 1 and 2.

HEADQUARTERS, DEPARTMENT OF THE ARMY
JANUARY 29, 1983

D101.11:

READEX FICHE best copy available

CHANGE

No. 2

DEPARTMENTS OF THE ARMY
AND THE AIR FORCE
Washington, DC, 1 January 1988

OPERATOR'S, ORGANIZATIONAL, DIRECT SUPPORT AND GENERAL SUPPORT MAINTENANCE MANUAL FOR SIGNAL GENERATOR SG-1170/U (WAVETEK MODEL 3001) (NSN 6625-01-120-3501)

TM 11-6625-3029-14, 29 January 1983, is changed as follows:

1. Remove old pages and insert new pages as indicated below. New or changed material is indicated by a vertical bar in the margin of the page. Added or revised illustrations are indicated by a vertical bar adjacent to the identification number.

Remove pages	*Insert pages*
2-5 and 2-6	2-5 and 2-6

2. File this change sheet in the front of the publication for reference purposes.

Distribution authorized to the Department of Defense and DOD contractors only for official use or for administration or operational purposes. This determination was made on 1 October 1987. Other requests for this document will be referred to Commander, US Army Communications-Electronics Command and Fort Monmouth, ATTN: AMSEL-LC-ME-P, Fort Monmouth, NJ 07703-5000.

DESTRUCTION NOTICE—Destroy by any method that will prevent disclosure of contents or reconstruction of the document.

By Order of the Secretary of the Army:

CARL E. VUONO
General, United States Army
Chief of Staff

Official:

R.L. DILWORTH
Brigadier General, United States Army
The Adjutant General

DISTRIBUTION:
To be distributed in accordance with DA Form 12-36 Operator, Unit, and DS/GS requirements for SG-1170/U.

Change

No. 1

HEADQUARTERS
DEPARTMENT OF THE ARMY
Washington, DC,

OPERATOR'S, ORGANIZATIONAL, DIRECT SUPPORT, AND GENERAL SUPPORT MAINTENANCE MANUAL

SIGNAL GENERATOR SG-1170/U
(WAVETER MODEL 3001)
(NSN 6625-01-120-3501)

TM 11-6625-3029-14, 29 January 1983, is changed as follows:

1. Remove old pages and insert new pages as indicated below. New or changed material is indicated by a vertical bar in the margin of the page. Added or revised illustrations are indicated by a vertical bar adjacent to the identification number.

Remove pages	*Insert pages*
i through vii/(viii blank)	i through vii/(viii blank)
1-1 through 1-4	1-1 through 1-4
3-1 and 3-2	3-1 and 3-2
3-11 and 3-12	3-11 and 3-12
3-15 and 3-16	3-15 and 3-16
3-27 and 3-28	3-27 and 3-28
4-3 and 4-4	4-3 and 4-4
4-9 through 4-12	4-9 through 4-12
4-25 and 4-26	4-25 and 4-26
5-7 through 5-14	5-7 through 5-14
A-1/(A-2 blank)	A-1/(A-2 blank)
Figure FO-1	Figure FO-1
Figure FO-14	Figure FO-14

2. File this change sheet in the front of the publication for reference purposes.

This publication is required for official use or for administrative or operational purposes only. Distribution is limited to US Government Agencies. Other requests for this document must be referred to Commander, US Army Communications-Electronics Command and Fort Monmouth, ATTN: AMSEL-ME-P, Fort Monmouth, NJ 07703-5000.

By Order of the Secretary of the Army:

JOHN A. WICKHAM, JR.
General, United States Army
Chief of Staff

Official:

R.L. DILWORTH
Brigadier General, United States Army
The Adjutant General

DISTRIBUTION:
To be distributed in accordance with DA Form 12-36 literature requirements for SG-1170/U.

This manual contains copyright material reproduced by permission of WAVETEK.

TECHNICAL MANUAL

No. 11-6625-3029-14

TM 11-6625-3029-14

HEADQUARTERS
DEPARTMENT OF THE ARMY
Washington, DC, 29 January 1983

OPERATOR'S, ORGANIZATIONAL, DIRECT SUPPORT, AND GENERAL SUPPORT MAINTENANCE MANUAL

FOR

SIGNAL GENERATOR SG-1170/U

(WAVETEK MODEL 3001)

(NSN 6625-01-120-3501)

REPORTING ERRORS AND RECOMMENDING IMPROVEMENTS

You can help improve this manual. If you find any mistakes or if you know of a way to improve the procedures, please let us know. Mail your letter, DA Form 2028 (Recommended Changes to Publications and Blank Forms), or DA Form 2028-2 located in the back of this manual direct to: Commander, US Army Communications-Electronics Command and Fort Monmouth, ATTN: AMSEL-ME-MP, Fort Monmouth, NJ 07703-5000. A reply will be furnished to you.

This manual is an authentication of the manufacturer's commercial literature which, through usage, has been found to cover the data required to operate and maintain this equipment. Since the manual was not prepared in accordance with military specifications, the format has not been structured to consider levels of maintenance.

WARNING

DANGEROUS VOLTAGES EXIST IN THIS EQUIPMENT

Dangerous potentials exist at several points throughout this equipment. When the equipment is operated with the cover removed, DO NOT touch exposed connections or components. Disconnect power before cleaning the equipment or replacing parts.

DON'T TAKE CHANCES!

WARNING

Adequate ventilation should be provided while using TRICHLOROTRIFLUOROETHANE. Prolonged breathing of vapor should be avoided. The solvent should not be used near heat or open flame; the products of decomposition are toxic and irritating. Since TRICHLOROTRIFLUOROETHANE dissolves natural oils, prolonged contact with skin should be avoided. When necessary, use gloves which the solvent cannot penetrate. If the solvent is taken internally, consult a physician immediately.

CONTENTS

SECTION	1	GENERAL INFORMATION	
	1.1	SCOPE	1-1
	1.1.1	CONSOLIDATED INDEX OF ARMY PUBLICATIONS AND BLANK FORMS	1-1
	1.1.2	MAINTENANCE FORMS, RECORDS AND REPORTS	1-1
	1.1.3	REPORTING EQUIPMENT IMPROVEMENT RECOMMENDATIONS (EIR)	1-1
	1.1.4	ADMINISTRATIVE STORAGE	1-1
	1.1.5	DESTRUCTION OF ARMY MATERIEL	1-1
	1.2	DESCRIPTION AND DATA	1-2
	1.2.1	PURPOSE AND USE	1-2
	1.2.2	FREQUENCY SPECIFICATIONS	1-2
	1.2.3	RF OUTPUT SPECIFICATIONS	1-2
	1.2.4	SPECTRAL PURITY	1-3
	1.2.5	AMPLITUDE MODULATION	1-3
	1.2.6	FREQUENCY MODULATION	1-4
	1.2.7	REVERSE POWER PROTECTION	1-4
	1.2.8	GENERAL	1-4
SECTION	2	INSTALLATION AND OPERATION	
	2.1	INTRODUCTION	2-1
	2.2	MECHANICAL INSTALLATION	2-1
	2.2.1	INITIAL INSPECTION	2-1
	2.2.2	RACK MOUNTING (K108)	2-1
	2.3	ELECTRICAL INSTALLATION	2-1
	2.4	DESCRIPTION OF FRONT PANEL	2-3
	2.5	DESCRIPTION OF REAR PANEL	2-3
	2.6	INSTALLATION CHECKS	2-3
	2.6.1	TURN ON	2-3
	2.6.2	INITIAL CONTROL ADJUSTMENT	2-6
	2.6.3	RF OUTPUT CHECK	2-6
	2.6.4	AM MODULATION CHECK (1000 Hz)	2-6
	2.6.5	AM MODULATION CHECK (400 Hz)	2-6
	2.6.6	FMx1 CHECK	2-6
	2.6.7	FMx10 CHECK	2-6
	2.6.8	MODULATION FM/AM SLIDER CHECK (FREQUENCY)	2-6
	2.6.9	MODULATION FM/AM SLIDER CHECK (OUTPUT)	2-6
	2.6.10	FREQ VERNIER CHECK	2-6
	2.7	OPERATING PROCEDURE	2-6
	2.7.1	TURN ON	2-6
	2.7.2	FREQUENCY SELECTION	2-6
	2.7.3	OUTPUT LEVEL SELECTION	2-6
	2.7.4	AMPLITUDE MODULATION – INTERNAL	2-6
	2.7.5	AMPLITUDE MODULATION – EXTERNAL	2-7
	2.7.6	FREQUENCY MODULATION – INTERNAL	2-7
	2.7.7	FREQUENCY MODULATION – EXTERNAL	2-7
	2.7.8	MODULATION FM/AM SLIDER – AM	2-7
	2.7.9	FREQ VERNIER	2-7
	2.7.10	PROGRAMMING	2-7

CONTENTS (Continued)

SECTION	3	THEORY OF OPERATION	
	3.1	INTRODUCTION	3-1
	3.2	OVERALL BLOCK DIAGRAM	3-1
	3.2.1	BASIC SIGNAL GENERATOR	3-1
	3.2.2	PHASE-LOCKED LOOPS	3-4
	3.2.3	SUBASSEMBLY DESCRIPTIONS	3-10
	3.3	C315 – METER BOARD	3-10
	3.3.1	LEVEL PROGRAM	3-10
	3.3.2	MODULATION	3-10
	3.3.3	METER	3-10
	3.3.4	UNLEVELED LIGHT	3-12
	3.4	C316-6 – MODULATION BOARD	3-12
	3.4.1	MODULATING SIGNALS	3-12
	3.4.2	ACCURACY LIGHTS	3-12
	3.5	DPS2C – POWER SUPPLY	3-12
	3.5.1	TRANSFORMERS & FILTERS	3-12
	3.5.2	+18 V SUPPLY	3-12
	3.5.3	-18 V SUPPLY	3-12
	3.5.4	+7.3 V SUPPLY	3-12
	3.6	IM35-2 - RF CIRCUIT BREAKER	3-12
	3.7	M9W-5 – SWEEP OSCILLATOR	3-12
	3.7.1	MIXER	3-18
	3.7.2	WIDE OSCILLATOR	3-18
	3.7.3	NARROW OSCILLATOR	3-18
	3.7.4	LEVELERS	3-18
	3.8	M10W-10 – OUTPUT AMPLIFIER	3-18
	3.8.1	SWITCH	3-18
	3.8.2	AMPLIFIER	3-18
	3.8.3	LEVELER	3-18
	3.8.4	UNLEVELED LIGHT DRIVER	3-18
	3.9	M172 – SWEEP DRIVE/DAC	3-18
	3.10	M29-2 – FM REFERENCE	3-21
	3.10.1	CURRENT SOURCES	3-21
	3.10.2	OSCILLATOR	3-21
	3.11	M30-8 – CRYSTAL REFERENCE	3-21
	3.11.1	40 MHz OSCILLATOR	3-21
	3.11.2	DIVIDERS	3-21
	3.11.3	MULTIPLIERS	3-21
	3.12	M31A – kHz STEPS	3-21
	3.12.1	VCO	3-21
	3.12.2	PHASE-LOCKED LOOP	3-21
	3.12.3	PROGRAMMABLE DIVIDER	3-25
	3.12.4	UNLOCK INDICATOR	3-25
	3.13	M32A-2 – MHz STEPS	3-25
	3.13.1	VCO	3-25
	3.13.2	PROGRAMMABLE DIVIDER	3-25
	3.13.3	PHASE DETECTOR	3-25
	3.13.4	UNLOCKED INDICATOR	3-25

CONTENTS (Continued)

	3.14	M33-2 – NARROW OSCILLATOR LOCK. 3-25
	3.14.1	PHASE DETECTOR FOR PLL 3 3-25
	3.14.2	MIXER 3-25
	3.14.3	PHASE DETECTOR FOR PLL 5 3-27
	3.14.4	UNLOCK INDICATOR 3-27
	3.15	M34-1 – WIDE OSCILLATOR LOCK. 3-27
	3.15.1	PHASE DETECTOR 3-27
	3.15.2	FREQUENCY OFFSET CIRCUIT 3-27
	3.15.3	AUXILIARY CIRCUITS 3-27
	3.16	M115 – DOWN CONVERTER 3-27
SECTION	**4**	**PERFORMANCE TESTS**
	4.1	INTRODUCTION 4-1
	4.2	FREQUENCY RANGE AND RESOLUTION TEST. 4-3
	4.3	FREQUENCY ACCURACY TEST 4-3
	4.4	FREQUENCY STABILITY TEST 4-5
	4.5	OUTPUT LEVEL ACCURACY TESTS 4-5
	4.5.1	OUTPUT METER ACCURACY TEST. 4-7
	4.5.2	FLATNESS TEST 4-7
	4.5.3	STEP ATTENUATOR ACCURACY TEST. 4-8
	4.6	HARMONICS TEST 4-10
	4.7	NON-HARMONICS TEST. 4-11
	4.8	RESIDUAL AM TEST 4-12
	4.9	RESIDUAL FM TEST 4-13
	4.10	INTERNAL MODULATION FREQUENCY TEST 4-14
	4.11	PERCENT AM ACCURACY TEST. 4-14
	4.12	AM BANDWIDTH TEST 4-17
	4.13	AM DISTORTION TEST 4-18
	4.14	FM DEVIATION ACCURACY TEST 4-19
	4.15	FM BANDWIDTH TEST. 4-20
	4.16	FM DISTORTION TEST 4-21
	4.17	IMPEDANCE TEST. 4-21
	4.18	RFI TEST 4-23
	4.19	RF PROTECTION CHECK. 4-25
	****	PERFORMANCE TEST RECORD 4-26

CONTENTS (Continued)

SECTION	5	MAINTENANCE	
	5.1	INTRODUCTION	5-1
	5.2	SERVICE INFORMATION	5-1
	5.2.1	DISASSEMBLY INFORMATION	5-1
	5.2.2	MODULE SERVICING	5-1
	5.2.3	PRINTED-CIRCUIT BOARD SERVICING	5-3
	5.2.4	RECOMMENDED TEST EQUIPMENT	5-3
	5.3	ALIGNMENT PROCEDURE	5-3
	5.3.1	+18 VOLT ADJUSTMENT	5-3
	5.3.2	-18 VOLT ADJUSTMENT	5-3
	5.3.4	CRYSTAL FREQUENCY ADJUSTMENT M30-8	5-3
	5.3.5	PHASE-LOCKED LOOP 1 ADJUSTMENT M31A	5-4
	5.3.6	PHASE-LOCKED LOOP 2 ADJUSTMENT M32A-2	5-4
	5.3.7	PHASE-LOCKED LOOP 3 ADJUSTMENT	5-4
	5.3.8	PHASE-LOCKED LOOP 4 ADJUSTMENT	5-4
	5.3.9	PHASE-LOCKED LOOP 5 ADJUSTMENT	5-5
	5.3.10	METER BOARD ADJUSTMENT – C315	5-5
	5.3.11	DOWN CONVERSION ADJUSTMENT – M115	5-8
	5.3.12	FINAL FREQUENCY CHECK – M30-8	5-8
	5.4	TROUBLESHOOTING	5-8
	5.4.1	TROUBLESHOOTING HINTS	5-9
	5.4.2	ASSEMBLY REPLACEMENT	5-12
	5.5	PREVENTIVE MAINTENANCE CHECKS AND SERVICES	5-14
	5.6	CLEANING	5-15
	5.7	TOUCH-UP PAINTING	5-15
SECTION	6	SCHEMATICS	
	6.1	INTRODUCTION	6-1
	6.2	SCHEMATIC NOTES	6-1
	****	INSTRUMENT WIRING DIAGRAM	F01
	****	SCHEMATIC – DPS2C POWER SUPPLY	F02
	****	SCHEMATIC – M30-8 CRYSTAL REFERENCE	F03
	****	SCHEMATIC – C316-6 MODULATION BOARD	F04
	****	SCHEMATIC – M29-2 FM REFERENCE	F05
	****	SCHEMATIC – M31A kHz STEPS	F06
	****	SCHEMATIC – M33-2 NARROW OSCILLATOR LOCK	F07
	****	SCHEMATIC – M172 SWEEP DRIVE/DAC	F08
	****	SCHEMATIC – M32A-2 MHz STEPS	F09
	****	SCHEMATIC – M34-1 WIDE OSCILLATOR LOCK	F010
	****	SCHEMATIC – M9W-5 SWEEP OSCILLATOR	F011
	****	SCHEMATIC – C315 METER BOARD	F012
	****	SCHEMATIC – M10W-10 OUTPUT AMPLIFIER	F013
	****	SCHEMATIC - M35-2 CIRCUIT BREAKER	F014
	****	SCHEMATIC – M115 DOWN CONVERTER	F015
APPENDIX			
	A	REFERENCES	A-1
	B	COMPONENTS OF END ITEM AND BASIC ISSUE ITEMS LISTS (NOT APPLICABLE)	B-1
	C	ADDITIONAL AUTHORIZATION LIST (NOT APPLICABLE)	C-1
	D	MAINTENANCE ALLOCATION	D-1
	E	EXPENDABLE SUPPLIES AND MATERIALS LIST	E-1

LIST OF ILLUSTRATIONS

FIGURE		
2-1	K108 RACK MOUNT	2-2
2-2	FRONT PANEL	2-2
2-3	REAR PANEL	2-4
2-4	TEST SET-UP FOR INSTALLATION CHECKS	2-5
2-5	AMPLITUDE MODULATION	2-5
2-6	FREQUENCY MODULATION	2-5
2-7	PIN IDENTIFICATION	2-8
3-1	BASIC BLOCK DIAGRAM	3-2
3-2	PHASE-LOCKED LOOP RELATIONSHIPS	3-3
3-3	PHASE-LOCKED LOOP 1	3-3
3-4	PHASE-LOCKED LOOP 2	3-5
3-5a	PHASE-LOCKED LOOP 4	3-6
3-5b	PHASE-LOCKED LOOP 4	3-7
3-6	PHASE-LOCKED LOOP 3	3-8
3-7	PHASE-LOCKED LOOP 5	3-9
3-8	C315 METER BOARD	3-11
3-9	C316-6 MODULATION BOARD	3-13
3-10	DPS2C POWER SUPPLY	3-14
3-11	M35-2 RF CIRCUIT BREAKER	3-15
3-12	M9W-5 OUTPUT AMPLIFIER	3-16
3-13	M10W-10 OUTPUT AMPLIFIER	3-17
3-14	M172 SWEEP DRIVE/DAC	3-19
3-15	M29-2 FM REFERENCE	3-20
3-16	M30-8 CRYSTAL REFERENCE	3-22
3-17	M31A kHz STEPS	3-23
3-18	M32A-2 MHz STEPS	3-24
3-19	M33-2 NARROW OSCILLATOR LOCK	3-26
3-20	M34-1 WIDE OSCILLATOR LOCK	3-28
3-21	M34-1 FREQUENCIES	3-29
3-22	M34-1 FREQUENCIES (EXPANDED)	3-30
3-23	M115 DOWN CONVERTER	3-31
4-1	SET-UP FOR STEP ATTENUATOR TESTS	4-9
4-2	SET-UP FOR DISTORTION TESTS	4-9
4-3	SET-UP FOR PERCENT AM ACCURACY TEST	4-16
4-4	SET-UP FOR AM BANDWIDTH TEST	4-16
4-5	SET-UP FOR IMPEDANCE TEST	4-22
4-6	LOOP PROBE	4-24
4-7	SET-UP FOR RFI TEST	4-24
5-1	DISASSEMBLY	5-2
5-2	MODULE PIN NUMBERING	5-2
5-3	CONNECTOR ALIGNMENT	5-2
5-4	M172 CONTROLS	5-5
5-5	BOTTOM VIEW	5-6
5-6	TOP VIEW	5-7

SECTION 1

GENERAL INFORMATION

1.1 SCOPE

This manual describes Signal Generator SG-1170/U and provides instructions for operation and maintenance. Throughout this manual the SG-1170/U is referred to as "instrument".

1.1.1 CONSOLIDATED INDEX OF ARMY PUBLICATIONS AND BLANK FORMS

Refer to the latest issue of DA Pam 310-1 to determine whether there are new editions, changes, or additional publications pertaining to the equipment.

1.1.2 MAINTENANCE FORMS, RECORDS AND REPORTS

a. *Reports of Maintenance and Unsatisfactory Equipment.* Department of the Army forms and procedures used for equipment maintenance will be those prescribed by DA Pam 738-750 as contained in Maintenance Management Update.

b. *Report of Packaging and Handling Deficiencies.* Fill out and forward SF 364 (Report of Discrepancy (ROD)) as prescribed in AR 735-11-2/DLAR 4140.55/ NAVMATINST 4355.73A/AFR 400-54/MCO 4430.3H.

c. *Discrepancy in Shipment Report (DISREP) (SF 361).* Fill out and forward Discrepancy in Shipment Report (DISREP) (SF 361) as prescribed in AR 55-38/ NAVSUPINST 4610.33C/AFR 75-18/MCO P4610.19D/DLAR 4500.15.

1.1.3 REPORTING EQUIPMENT IMPROVEMENT RECOMMENDATIONS (EIR)

If your SIG-1170/U needs improvement, let us know. Send us an EIR. You, the user, are the only one who can tell us what you don't like about the design. Put it on an SF 368 (Quality Deficiency Report). Mail it to: Commander, US Army Communications-Electronics Command and Fort Monmouth, ATTN: AMSEL-PA-MA-D, Fort Monmouth, New Jersey 07703-5000. We'll send you a reply.

1.1.4 ADMINISTRATIVE STORAGE

There are no special procedures for preparing this equipment for limited storage. Place all ancillary items in a bag and tie or tape the bag to the equipment. Place equipment in limited storage, i.e., organizational storage room. Protect equipment from dust, humidity, and extreme temperature changes.

1.1.5 DESTRUCTION OF ARMY MATERIEL

Demolition and destruction of electronic equipment will be under the direction of the commander and in accordance with TM 750-244-2.

1.2 DESCRIPTION AND DATA

1.2.1 PURPOSE AND USE

Signal Generator SG-1170/U is a rugged, completely solid-state signal generator covering the frequency range of from 0.001 to 520 MHz. The output can be amplitude or frequency modulated, and the level can be set between +13 and -137 dBm.

The frequency of the instrument is set via 6 front-panel Lever/Indicator switches which yield a resolution of 1 kHz. In addition, remote frequency programmability is standard.

The accuracy of the instrument is based on a crystal-controlled oscillator that serves as a stable frequency reference that enables the instrument to provide high stability signals to an accuracy of 0.001% over its specified frequency range. This accuracy includes possible errors due to short term drift, long term drift, incidental FM, and variations due to line voltage changes and temperature changes. With the FREQUENCY VERNIER out of the CAL position, the frequency is accurate to 0.001% ±10 kHz.

The instrument also features both internal and external amplitude and frequency modulation capabilities. Internal modulation frequencies of 400 Hz and 1 kHz are standard. In the FM mode of operation, peak deviations to 100 kHz are attainable. In the AM mode, amplitude modulation to 90% is attainable.

With the MODULATION MODE switch in the AM position and the MODULATION FREQUENCY switch in the DC position, the output amplitude can be varied by the MODULATION FM/AM control. This provides a reference attenuator for variation of signal level around a specific point of interest. This operation can also enable the user to obtain greater than 20 milliwatts of power over portions of the band. The frequency can also be continuously varied with this control over a 100 kHz range.

The output power is indicated on a front-panel meter calibrated in both dBm and VRMS. A fifteen-position, 10 db/step Attenuator used in conjunction with an 11 dB VERNIER control provides the user with a range of +13 dBm to -137 dBm.

The calibrated output of the instrument is leveled to within ±0.75 dB across the complete frequency range of the instrument.

Reverse power protection is provided.

1.2.2 FREQUENCY SPECIFICATIONS

RANGE	0.001 to 520 MHz selectable in 1 kHz steps.
READOUT	6 digit Lever/Indicator switches
RESOLUTION	1 kHz
ACCURACY	All modes (CW, AM and FM) ±0.001% after 15 min. (±0.001% ±10 kHz when FREQUENCY VERNIER is not in CAL position. FREQUENCY VERNIER range is ±5 kHz.)
CARRIER SHIFT	≤.005% for FM deviations ≤25 kHz
STABILITY	All modes (CW, AM and FM) < 0.2 ppm/hour (500 Hz per 10 min. when FREQUENCY VERNIER is not in CAL position.)
PROGRAMMABILITY	Frequency is programmable via rear-panel input connector using BCD-coded TTL voltages or BCD-coded contact closures (negative true logic).

1.2.3 RF OUTPUT SPECIFICATIONS

POWER LEVEL RANGE	+13 dBm to -137 dBm (1 to .03 μVRMS)
LEVEL CONTROL	Continuously adjustable in 10 dB steps with an 11 dB VERNIER. Output level is indicated on a front-panel METER calibrated in volts RMS and dBm.

LEVEL ACCURACY

Flatness — (+13 to -7 dBm) ±0.75 dB

Output METER — ±0.5 dB

Step Attenuator — ≤ ±0.2 dB/10 dB step (±0.2 dB calibration error)

IMPEDANCE — 50 ohms

SWR — < 1.25 at RF output levels below 0.1 VRMS

OUTPUT CONNECTOR — Type N

RFI LEAKAGE — < 1 μV is induced in a two-turn, one-inch diameter loop which is held one inch away from any surface. Loop feeds a 50 ohm receiver.

1.2.4 SPECTRAL PURITY

HARMONIC OUTPUT — < -30 dBc from 10 to 520 MHz and 1 kHz to 1 MHz

< -26 dBc from 1 to 10 MHz

SUB-HARMONICS — None detectable

NON-HARMONICS

Fundamental (MHz)	Non-Harmonic (MHz)	Non-Harmonic Level (dBc)
below 3	below 3	< -60
3 to 250	3 to 250	< -65
3 to 350	3 to 350	< -55
3 to 520	3 to 1000	< -35

RESIDUAL AM — < -65 dBc in a 50 Hz to 15 kHz post-detection bandwidth.

FM INCIDENTAL AM — < 1% for FM deviation of 40 kHz

RESIDUAL FM — < 200 Hz in 50 Hz to 15 kHz post-detection bandwidth.

< 100 Hz in 300 Hz to 3 kHz post-detection bandwidth.

SSB PHASE NOISE — < -100 dBc/Hz at 20 kHz offset from carrier

FLOOR NOISE — < -115 dBc/Hz at 500 kHz offset from carrier

1.2.5 AMPLITUDE MODULATION

NOTE: These specifications apply for a carrier level ≤ +3 dBm. AM is possible above +3 dBm if the peak output does not exceed +13 dBm.

FREQUENCY

Internal — 400 Hz and 1 kHz ±5%

External — DC to 20 kHz, (3 dB bandwidth). Input level required = 5 Vpp into 600 ohms to provide calibrated % modulation control.

RANGE	0 to 90%
DISTORTION	0 to 30% AM, <2%
	30 to 70% AM, <3%
	70 to 90% AM, <5%
MODULATION CONTROL	Calibrated from 0 to 90%
Accuracy	± (5% +5% of reading) at a frequency of 1 kHz

1.2.6 FREQUENCY MODULATION

FREQUENCY	
Internal	400 Hz and 1 kHz, ±5%
External	50 Hz to 30 kHz. (DC to 25 kHz when FREQUENCY VERNIER is not in CAL position.) Input level required = 5 Vpp into 600 ohms to provide calibrated deviation control. (Voltage required for 10 kHz deviation from 100 Hz to 15 kHz varies <±10% from voltage required at 1 kHz. Voltage required for 10 kHz deviation from 15 to 30 kHz varies <±20% from voltage required at 1 kHz.)
DEVIATION PEAK	Two bands, 0 to 10 kHz, and 0 to 100 kHz
DEVIATION CONTROL	Calibrated from 0 to 10 kHz, x1 and x10
Accuracy	±500 Hz on x1 range ±5 kHz on x10 range
DISTORTION	< 2% (10 kHz to 100 kHz deviation) at a frequency of 1 kHz.
	< 4% (3 kHz to 10 kHz deviation) at a frequency of 1 kHz.

1.2.7 REVERSE POWER PROTECTION This circuit prevents damage to the instrument if RF (0.7W max) or DC (72.5 V max) voltages are accidently applied to the RF OUT connctor.

1.2.8 GENERAL

OPERATING TEMPERATURE	25° C ±5° C, all specifications apply
	25° C ±15° C, with slight degradation of specifications
POWER	100, 120, 220 or 240 VAC ± 10%; 45 to 440 Hz, 100 VA max
DIMENSIONS	30.3 cm wide x 13.4 cm high x 34.9 cm long (12" x 5-1/4" x 13-3/4").
WEIGHT	11.4 kg (24 lb)

SECTION 2

INSTALLATION AND OPERATION

2.1 INTRODUCTION

This section provides complete installation and operating instructions for the SG-1170/U. The instructions include information on mechanical installation, electrical installation, front- and rear-panel features, installation checks and operating procedures.

2.2 MECHANICAL INSTALLATION

2.2.1 INITIAL INSPECTION

After unpacking the instrument, visually inspect external parts for damage to knobs, connectors, surface areas, etc. The shipping container and packing material should be saved in case it is necessary to reship the unit.

2.2.2 RACK MOUNTING (K108)

NOTE

The K108 Rack Mount Kit is not normally supplied with the instrument.

CONTENTS (See Figure 2-1).

ITEM	QTY	PART NO.
A (Insert)	2 ea	1410-00-4650
B (Side)	2 ea	1410-00-5260
C (Screw)	8 ea	2810-17-8108
D (Screw)	4 ea	2810-17-8110

PROCEDURE

Remove the screws from one side panel. Mount items A and B against side panel of the instrument and secure with screws provided. Repeat for other side of unit. If rack mount kit is removed from unit, use screws originally installed in side panels to avoid possible internal damage.

2.3 ELECTRICAL INSTALLATION

The instrument can operate from 100, 120, 220, or 240 VAC supply mains. The rear-panel AC LINE connector selects which of these operating voltages is being used, and adjusts the Power Supply accordingly. The Power Supply is designed to operate over an AC supply frequency range of 45 to 440 Hz.

Instruments are shipped from the factory set up for 120 VAC operation unless otherwise specified.

NOTE

Before operating the instrument, check that the rear-panel AC LINE fuse is the correct value for the supply voltage (see Section 2.5).

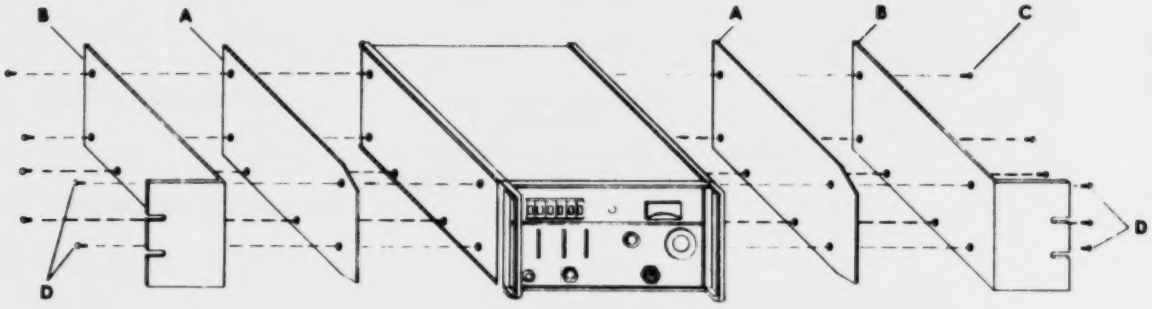


Figure 2-1. K108 Rack Mount

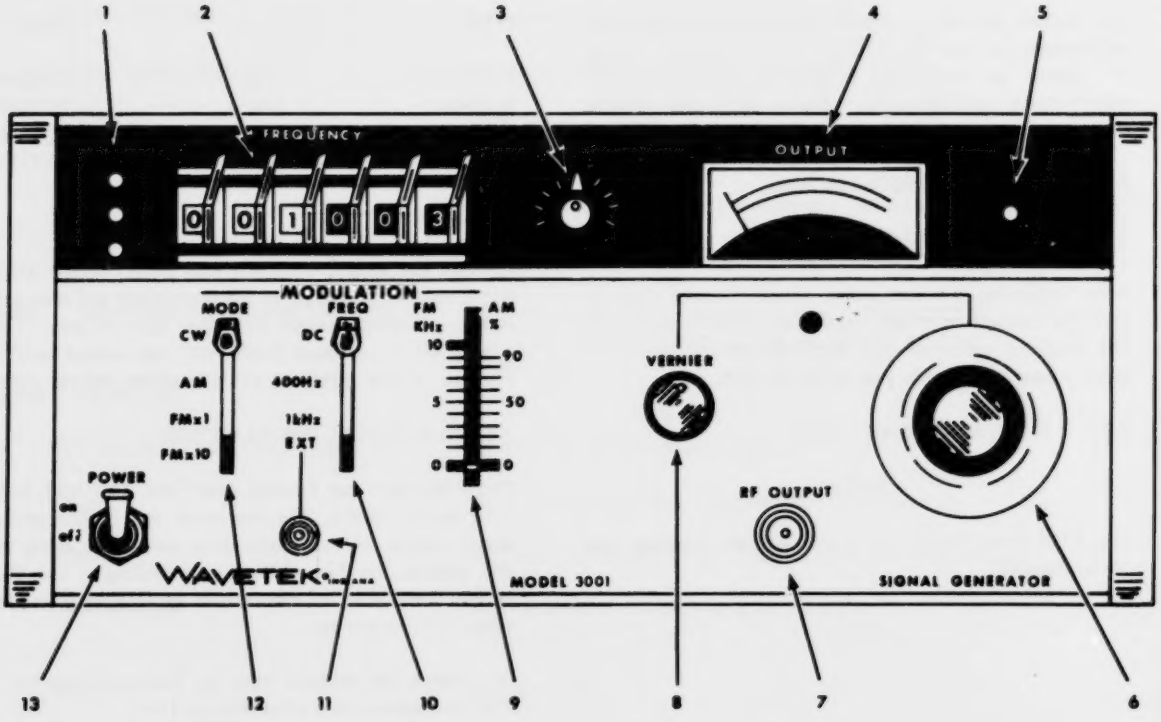


Figure 2-2. Front Panel

2.4 DESCRIPTION OF FRONT PANEL

Refer to Figure 2-2.

(1) ACCURACY lamps indicate the frequency accuracy of the instrument.

"VERNIER" indicates ±0.001% +10 kHz
"0.001%" indicates ±0.001%
"EXT" is not used

Typically, the lamp will flash for a few seconds after the instrument is turned on. Normally, a steady light indicates that the instrument is phase-locked and the frequency accuracy indicated is valid. A continuously flashing light indicates that one or more of the phase-locked loops is open.

(2) Lever/Indicator switches select and indicate output frequency.

(3) FREQ VERNIER shifts output frequency over a 10 kHz range (-5 kHz to +5 kHz).

With the FREQ VERNIER in CAL, the instrument accuracy is ±0.001%. When the FREQ VERNIER is not in CAL, the instrument accuracy is ±0.001% +10 kHz.

(4) OUTPUT METER indicates RF output level over a 10 dB range in VRMS and dBm.

(5) UNLEVELED lamp lights when the OUTPUT METER reading is not valid.

(6) OUTPUT Step Attenuator controls the RF output level over a 140 dB range from +10 to -130 dBm in 10 dB steps. The Attenuator dial indicates both dBm and VRMS.

(7) RF OUT provides the RF output signal from the instrument (type N connector).

(8) OUTPUT VERNIER controls the RF output level over an 11 dB range.

(9) MODULATION FM/AM slider determines the depth of amplitude modulation or peak frequency deviation depending on the setting of the MODULATION MODE switch (when the MODULATION MODE switch is set to CW, the FM/AM slider has no function).

(10) MODULATION FREQ switch selects the frequency of the signal used to modulate the RF output. The instrument has internal 400 Hz and 1 kHz sources, and a DC source for manual amplitude or frequency control. There is also provision for an external modulating signal.

(11) EXT MODULATION INPUT accepts external modulating signals as follows:

AM	DC to 20 kHz
FM (FREQ VERNIER in CAL)	50 Hz to 30 kHz
FM (FREQ VERNIER not in CAL)	DC to 30 kHz

A 5 Vpp signal into 600 ohms is required for FM/AM slider indication to be correct. A smaller input voltage will result in proportional reduction of the FM/AM slider indication; thus, a .5 Vpp signal into 600 ohms will result in a full scale indication of 10% AM, 1 kHz peak deviation in FMx1, or 10 kHz peak deviation in FMx10.

(12) MODULATION MODE switch selects CW, AM, FMx1, or FMx10 operation.

(13) POWER switch provides AC power to Power Supply.

2.5 DESCRIPTION OF REAR PANEL

Refer to Figure 2-3.

(1) AC LINE connector enables unit to operate from 100, 120, 220, or 240 VAC supply mains, and provides connection to AC mains via line cord with 3-prong plug. The connector also includes the AC LINE fuse (time-delay); 1.0 amp for 100 or 120 VAC operation; 0.5 amp for 220 or 240 VAC operation.

(2) PROGRAMMING jack provides connection for remote programming of frequency. Pin 36 is the MOD TP, which provides a convenient connection for monitoring the amplitude and/or frequency of the internal modulating signal.

2.6 INSTALLATION CHECKS

The following procedure is used to determine that the instrument is operating properly. Performance testing and calibration procedures for the instrument are contained in other sections of this manual. If it is determined that the unit is not operating properly, refer to these sections.

2.6.1 TURN ON

Verify that the power-transformer primary is matched to the available line voltage, and that the proper fuse is installed (see Section 2.5). Turn the POWER switch to ON. One of the front-panel ACCURACY lamps will indicate operation. No warmup is needed for the following checks.

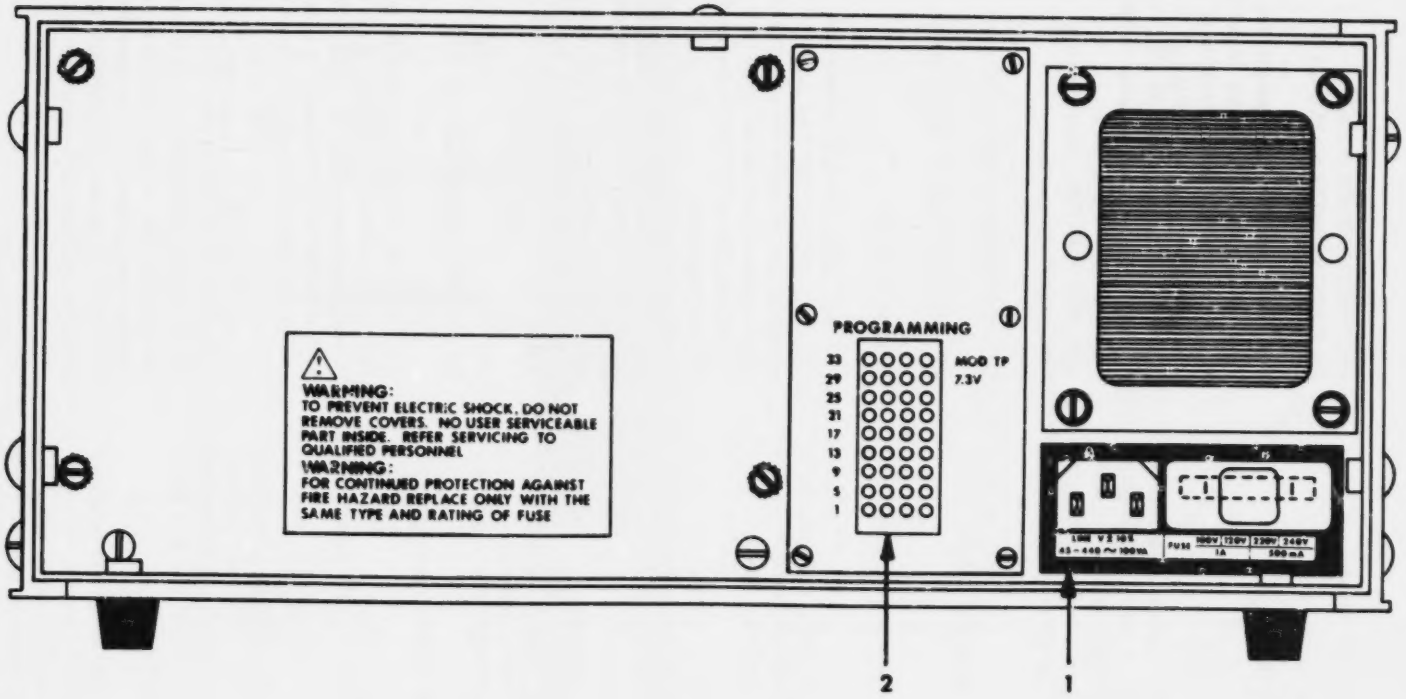


Figure 2-3. Rear Panel

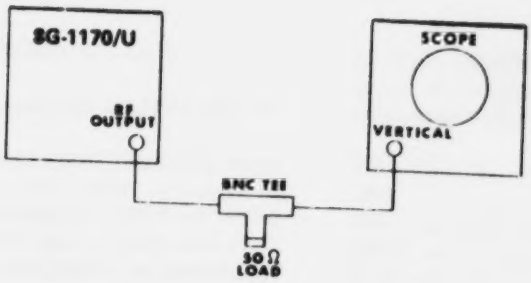


Figure 2-4. Test Set-up for Installation Checks

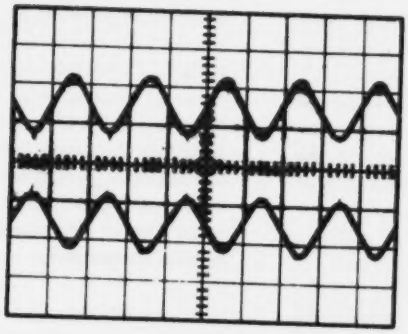


Figure 2-5. Amplitude Modulation

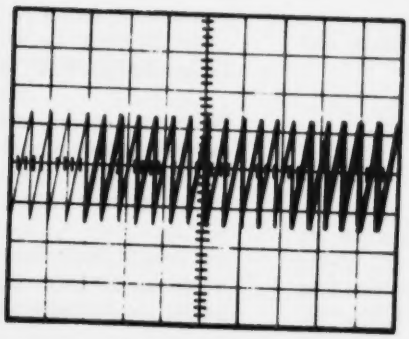


Figure 2-6. Frequency Modulation

2.6.2 INITIAL CONTROL ADJUSTMENT

Set the instrument front-panel controls as follows:

Lever/Indicator switches	001.000
FREQ VERNIER	CAL
MODULATION MODE	CW
MODULATION FREQ	1 kHz
MODULATION FM/AM	0
OUTPUT Step	0 dBm
OUTPUT VERNIER	full cw

2.6.3 RF OUTPUT CHECK

Connect the equipment as shown in Figure 2-4. The 1 MHz signal should be ~0.9 Vpp. (A high-frequency oscilloscope must be used for these checks.)

2.6.4 AM MODULATION CHECK (1000 Hz)

Set the MODULATION MODE switch to AM. Move the MODULATION FM/AM slider up to its 50% modulation point. Verify that the AM envelope displayed on the oscilloscope shows a peak-to-valley voltage difference of ~.45 V and a period of 1 msec (see Figure 2-5).

2.6.5 AM MODULATION CHECK (400 Hz)

Set the MODULATION FREQ switch to its 400 Hz position. Verify that the AM envelope period is 2.5 msec.

2.6.6 FMx1 CHECK

Set the MODULATION MODE switch to FMx1. Move the MODULATION FM/AM slider up and down. Verify that oscilloscope shows an FM display (see Figure 2-6).

2.6.7 FMx10 CHECK

Set the MODULATION MODE switch to FMx10 and repeat the above check.

2.6.8 MODULATION FM/AM SLIDER CHECK (FREQUENCY)

Set the FREQ VERNIER to "0 kHz". While leaving the MODULATION MODE switch in the FMx10 position, set the MODULATION FREQUENCY switch to DC. Verify that moving the MODULATION FM/AM slider from 0 to 10 kHz shows an increase in frequency on the oscilloscope.

2.6.9 MODULATION FM/AM SLIDER CHECK (OUTPUT)

Set the MODULATION MODE switch to AM. Verify that moving the MODULATION FM/AM slider from 0 to 50 shows an increase in output amplitude.

NOTE

The UNLEVELED light may come on during this test.

2.6.11 FREQ VERNIER CHECK

Switch the FREQ VERNIER out of CAL position. The .001% lamp should go out, and the VERNIER lamp should light. Moving the VERNIER from -5 kHz to +5 kHz should show a slight change in frequency on oscilloscope.

2.7 OPERATING PROCEDURE

No preparation for operation is required beyond completion of the initial installation checks contained in Section 2.6. To insure that the instrument will perform as stated in the specifications, the instrument should have a two-hour warmup before using.

2.7.1 TURN ON

Turn the POWER switch on. One of the front-panel ACCURACY lamps will light, indicating an operating condition. A flashing lamp indicates an unlocked condition. This should cease in a few seconds. If the unit is not going to be used to the extreme limits of its specifications, it can be used immediately.

NOTE

If an external RF voltage of approximately 6 VRMS or more is accidentally applied to the instrument's RF OUT connector, an internal switch in series with the RF output will open and latch until reset, preventing damage to the instrument. This open switch will be indicated on the front panel by the flashing (or varying intensity, if instrument is unleveled) of the UNLEVELED lamp. After removing the RF signal causing the overload, the switch can be reset by momentarily turning the POWER switch off.

2.7.2 FREQUENCY SELECTION

Select the frequency desired with the six Lever/Indicator switches on the front-panel.

2.7.3 OUTPUT LEVEL SELECTION

Set the OUTPUT Step and VERNIER controls for the desired output level. The RF output equals the Step dial setting algebraically added to the METER indication.

2.7.4 AMPLITUDE MODULATION – INTERNAL

Set the MODULATION MODE switch to AM and the MODULATION FREQUENCY switch to either 400 or 1000. Adjust the MODULATION FM/AM slider for the desired modulation depth.

2.7.5 AMPLITUDE MODULATION – EXTERNAL

CAUTION

Input voltages greater than ±10 VDC or 10 VRMS should not be applied to the EXT MOD INPUT connector, or damage may occur to the instrument.

Set the MODULATION MODE switch to AM and the MODULATION FREQ switch to EXT. Apply a 5 Vpp signal into 600 ohms to the EXT MOD INPUT connector. The desired modulation depth can then be set. For AM, the upper frequency limit of this input is 20 kHz.

NOTE

When AM modulating, care must be taken not to exceed the +13 dBm maximum level or excessive distortion and an unleveled condition can exist. In some cases, a high % AM may cause the UNLEVELED light to come on when the OUTPUT VERNIER control is at minimum. This is caused by "bottoming" of the PIN diode leveler which, in turn, can cause an increase in distortion. If this is the case, add 10 dB of fixed attenuation, and turn the OUTPUT VERNIER control toward maximum. The UNLEVELED light should then go out.

2.7.6 FREQUENCY MODULATION – INTERNAL

Set the MODULATION MODE switch to FMx1 or FMx10 and the MODULATION FREQ switch to either 400 or 1000. Adjust the MODULATION FM/AM slider to the desired peak deviation.

2.7.7 FREQUENCY MODULATION – EXTERNAL

CAUTION

Input voltages treater than ±10 VDC or 10 VRMS should not be applied to the EXT MOD INPUT connector, or damage may occur to the instrument.

Set the MODULATION MODE switch to FMx1 or FMx10 and the MODULATION FREQ switch to EXT. Apply a 5 Vpp into 600 ohms signal to the EXT MOD INPUT connector. The desired peak deviation can then be set. For FM, the upper frequency limit of this input is 30 kHz. The lower limit is 50 Hz when the FREQ VERNIER is in CAL, or DC when the FREQ VERNIER is not in CAL.

2.7.8 MODULATION FM/AM SLIDER – AM

Set the MODULATION MODE switch to AM and the MODULATION FREQ switch to DC. Using the MODULATION FM/AM slider, the output amplitude can be varied. It also enables more than 20 mW of power to be obtained over portions of the band.

2.7.9 FREQ VERNIER

When the FREQ VERNIER is in CAL, output frequencies having an accuracy of ±0.001% may be selected by the Lever/Indicator switches with a resolution of 1 kHz. When the FREQ VERNIER is not in CAL, the selected output frequency can be shifted ±5 kHz with the FREQ VERNIER control. The output frequency at the "0" kHz position of the FREQ VERNIER corresponds closely to the output frequency in CAL.

2.7.10 PROGRAMMING

Frequency is programmable via a rear-panel input connector using standard 8-4-2-1 BCD contact closure or TTL signals. (Logic "0" = open = $\geq$ 2.2 V. Logic "1" = closed = $\leq$ 0.4 V.) The rear-panel PROGRAMMING jack pins are in parallel with the front-panel Lever/Indicator switches; thus, if rear-panel programming is to be implemented, the front-panel switches must indicate all zeroes.

Example - To program 130.152 MHz (refer to Figure 2-7):

FREQ DIGIT	1	3	0	1	5	2
GND PINS	4	7,8	–	16	18,20	23

CONNECTION		PIN
N.C.	100's	1
400		2
200		3
100		4
80	10's	5
40		6
20		7
10		8
8	1's	9
4		10
2		11
1		12
.8	.1's	13
.4		14
.2		15
.1		16
.08	.01's	17
.04		18
.02		19
.01		20
.008	.001's	21
.004		22
.002		23
.001		24
ground		25
N.C.		26 - 31
7.3V		32
N.C.		33 - 35
MOD T.P.		36

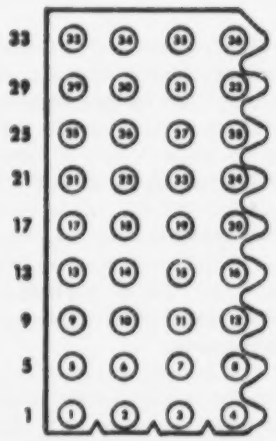


Figure 2-7. Pin Identification

SECTION 3

THEORY OF OPERATION

3.1 INTRODUCTION

Section 3.2 presents a block diagram analysis to enable the reader to get a brief overall view of the operation of the entire instrument. Sections 3.3 - 3.16 contain more detailed descriptions of each subassembly.

For actual wiring of the chassis and subassemblies, refer to the schematics in Section 6 of the manual.

3.2 OVERALL BLOCK DIAGRAM

The instrument is essentially a voltage-controlled oscillator to which phase-locked loops and a crystal reference have been added for the high frequency resolution.

The discussion will first deal with the basic signal generator, then it will describe how the phase-locked loops provide the additional accuracy.

The numbers within the block diagram symbols refer to the particular assembly in which the circuit is located.

3.2.1 BASIC SIGNAL GENERATOR

This discussion briefly describes how the RF is generated and how its frequency is controlled, and also how the signal is amplified, leveled and amplitude modulated.

Refer to Figure 3-1 for a block diagram of the basic signal generator without phase locking.

RF GENERATION

The RF output frequency is generated by two UHF oscillators and a mixer. The outputs of the two oscillators are heterodyned in the mixer. The difference frequency is amplified and fed to the Output Amplifier.

The frequencies of these oscillators are controlled by DC voltages applied to their varactor diodes. The Narrow Oscillator yields a single frequency. The Wide Oscillator can be programmed over a range which extends from the frequency of the Narrow Oscillator to 520 MHz higher than the Narrow Oscillator frequency.

RF FREQUENCY CONTROL

The RF output frequency is determined by programming the frequency of the Wide Oscillator. The Wide Oscillator is ultimately controlled by the front-panel Lever/Indicator switches. The BCD output of these switches is converted to an analog voltage which programs the oscillator in 1 MHz steps. This analog signal can provide approximately 3 MHz accuracy.

RF AMPLIFICATION AND LEVELING

The RF power is amplified by a multi-stage, wide-band amplifier. The flat output is maintained by a closed-loop leveling system around this Output Amplifier.

The leveler includes a monitor diode, an error amplifier and a voltage-variable attenuator. The monitor detects the peak of the output of the Output Amplifier. This detected level is compared to a DC reference by the error amp. The output of the error amp is fed to a PIN diode (voltage-variable) attenuator, which changes the input level to the Output Amplifier until the monitored signal produces a DC level equal to the reference level.

LEVEL CONTROL AND AM

The circuitry for controlling the RF output level is directly related to the above leveling system because changing the DC level reference changes the RF output level.

Of the 150 dB output range, 130 dB is passive attenuation. The remaining 20 dB is controlled by changing the level reference. The OUTPUT VERNIER has a 10 dB range. The remaining 10 dB is provided by switching the level reference range. This range switch is provided so that when AM is not required, the Output Amplifier can provide a carrier at the highest possible power.

Since the RF level can be voltage controlled, AM can be accomplished by applying the modulating signal to the OUTPUT VERNIER. This causes the reference voltage to the error amp to change at the frequency of the modulating signal. The modulating signal is taken from one of two internal oscillators, a DC voltage, or from an external source.

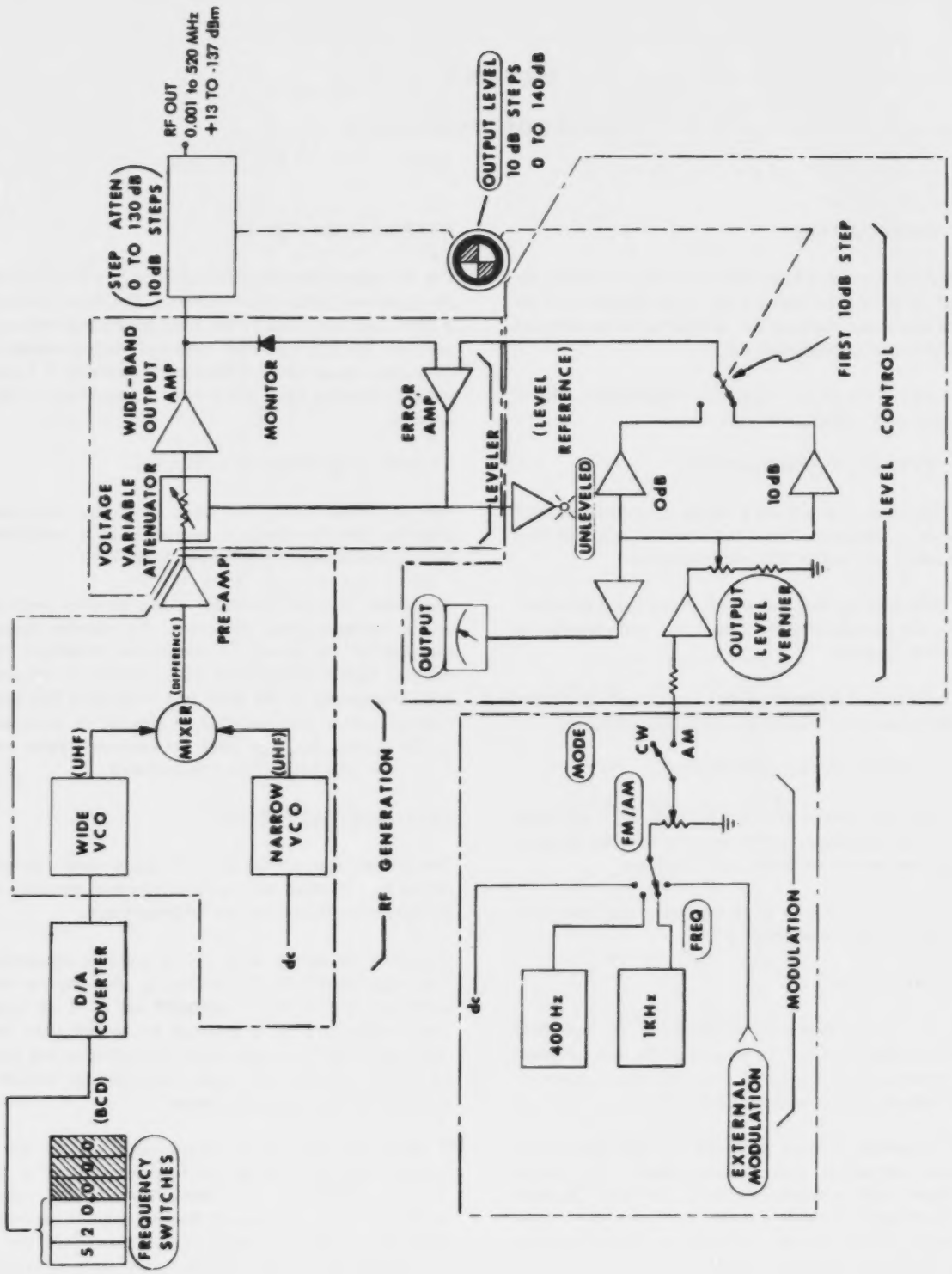


Figure 3-1. Basic Block Diagram

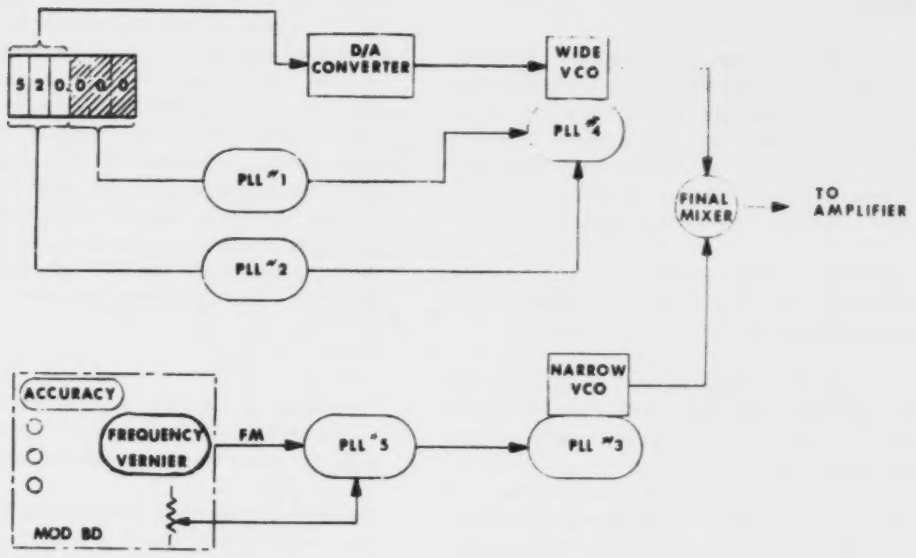


Figure 3-2. Phase-Locked Loop Relationships

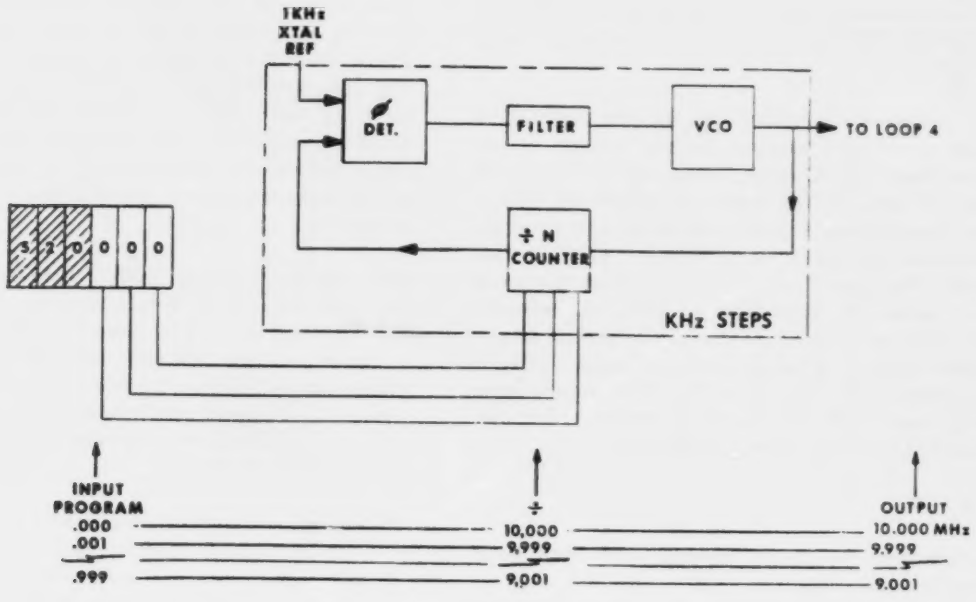


Figure 3-3. Phase-Locked Loop 1

3.2.2 PHASE-LOCKED LOOPS

The basic signal generator discussed in Section 3.2.1 has a frequency range of 1 to 520 MHz, has an output voltage which is leveled and adjustable and has the ability to be amplitude modulated. With the above circuitry, however, the frequency accuracy is only 3 MHz with 1 MHz resolution. To achieve the desired 1 kHz resolution and .001% accuracy, the instrument includes five phase-locked loops.

A down-conversion system enables the instrument to output frequencies less than 1 MHz. Its operation will be covered in Section 3.16.

PLL 1, 2, and 4 are used to stabilize the Wide Oscillator and tune it in 1 kHz steps. The Wide VCO is part of PLL 4. PLL 1 and 2 convert the Lever/Indicator switch setting to reference frequencies for PLL 4.

PLL 3 and 5 provide stabilization and allow FM operation. The Narrow VCO is part of PLL 3. PLL 5 converts a modulating signal (if present) to a reference frequency for PLL 3.

Figure 3-2 illustrates the relationship between the five numbered loops and the basic signal generator.

PLL 1

The purpose of PLL 1 is to generate a CW signal which changes in 1 kHz steps from 10.000 to 9.001 MHz as the front-panel frequency selector is switched from .000 MHz to .999 MHz. This signal will be used as a reference signal for PLL 4.

Figure 3-3 shows a simplified block diagram of PLL 1. It includes a voltage controlled oscillator capable of frequencies from 9 to 10 MHz, a phase detector, and a ÷N counter. A sample of the output signal from the VCO is fed to a programmable counter. The divisor of the counter is controlled by the three front-panel "kHz" selector switches. The output from the counter is fed to a phase detector where it is compared to a 1 kHz crystal reference signal. If the two input signals to the phase detector are not the same frequency, an error signal is produced. This error voltage corrects the frequency of the VCO until the phase detector input from the counter is exactly 1 kHz. See Section 3.12 for a more detailed explanation.

PLL 2

The purpose of PLL 2 is to generate a CW signal which changes in 1 MHz steps from 1448 to 1487 MHz when the front-panel frequency selector is switched from 001 to 039 MHz. These CW steps are then repeated every 40 MHz throughout the entire 1 to 520 MHz range. The use of this signal to control the Wide Oscillator will be discussed in the description of PLL 4.

Figure 3-4 shows a simplified block diagram of PLL 2. PLL 2 operates in the same manner as PLL 1 with one exception. The circuit includes a mixer and band-pass amplifier. The purpose of this additional circuitry is to offset the 1448 to 1487 MHz output from the VCO to 8 to 47 MHz. This offset is necessary in order to make the frequency compatible with the programmable counter and phase detector circuits. The other circuits in this loop operate the same as those in PLL 1. In this case, the programmable counter is controlled by the three "MHz" selector switches and the loop reference frequency is 1 MHz. For a more complete description, see Section 3.13.

PLL 4

The purpose of PLL 4 is to adjust the Wide Oscillator in 1 kHz steps from 1198 MHz to 1718 MHz as the front-panel frequency selector is adjusted from 1 to 520.000.

The Wide Oscillator frequency is offset by mixers 1 and 2 and compared to the reference (from PLL 1) by the phase detector. A difference in phase or frequency causes an error signal to tune the Wide Oscillator until both phase detector inputs are identical. How this loop locks on a particular frequency can best be explained in three steps: 1) phase locking at 40 MHz intervals across the band, 2) phase locking at 1 MHz intervals, 3) phase locking at 1 kHz intervals. Figure 3-5 is a simplified block diagram of PLL 4.

To understand locking at 40 MHz intervals, assume temporarily that the reference frequencies from PLL 1 and PLL 2 are fixed (10 MHz and 1448 MHz respectively). Figure 3-5 shows the frequencies throughout the loop for this discussion. This step of the PLL 4 explanation can be described more clearly by considering the entire Wide Oscillator range rather than discussing single frequencies. The Wide Oscillator covers the range of 1198 to 1718 MHz as the output frequency changes from 0 to 520 MHz (Figure 3-5, lines A and C).

When the Wide Oscillator range is heterodyned in mixer 1 with 1448 MHz, the difference frequency produced ranges from 250 to 0 to 270 MHz (Figure 3-5, line E). This signal is then mixed with a 40 MHz comb (all harmonics of 40 MHz) in mixer 2 (Figure 3-5, line F). Taking the difference between lines E and F yields the repetitive frequency range of from 0 to 20 to 0 MHz as shown in line G. This signal is fed to the phase detector.

The reference to the phase detector is 10 MHz, but the loop will not lock on every 10 MHz output of mixer 2. The only 10 MHz signals which will produce lock are those which would decrease in frequency if the Wide VCO tried to drift higher. Therefore, at every 40 MHz interval of the output frequency, an input to the phase detector would allow the loop to lock. Section 3.2.1 explains that an analog signal drives the Wide Oscillator to within three MHz of the

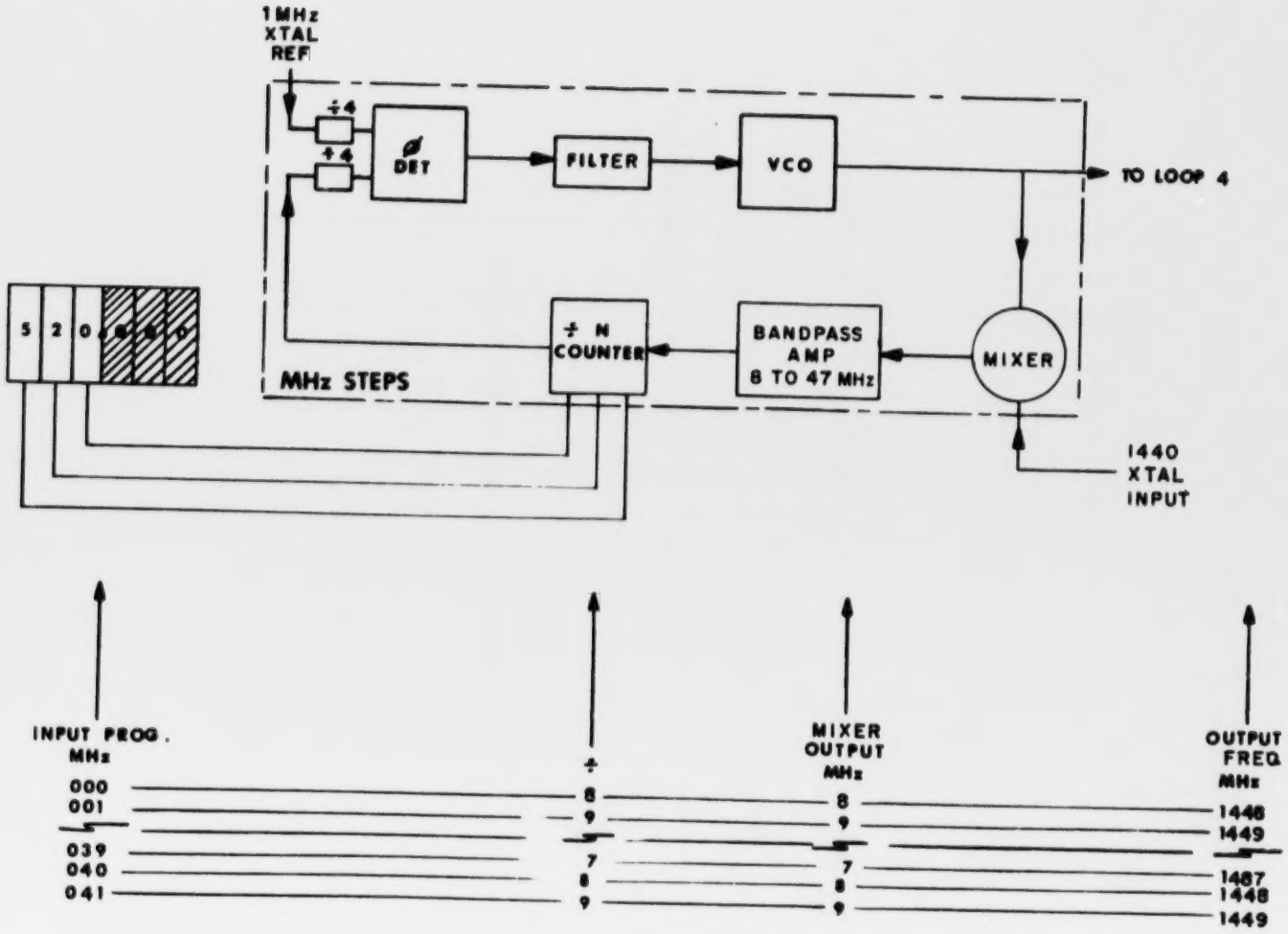


Figure 3-4. Phase-Locked Loop 2.

TM11-6625-3028-14

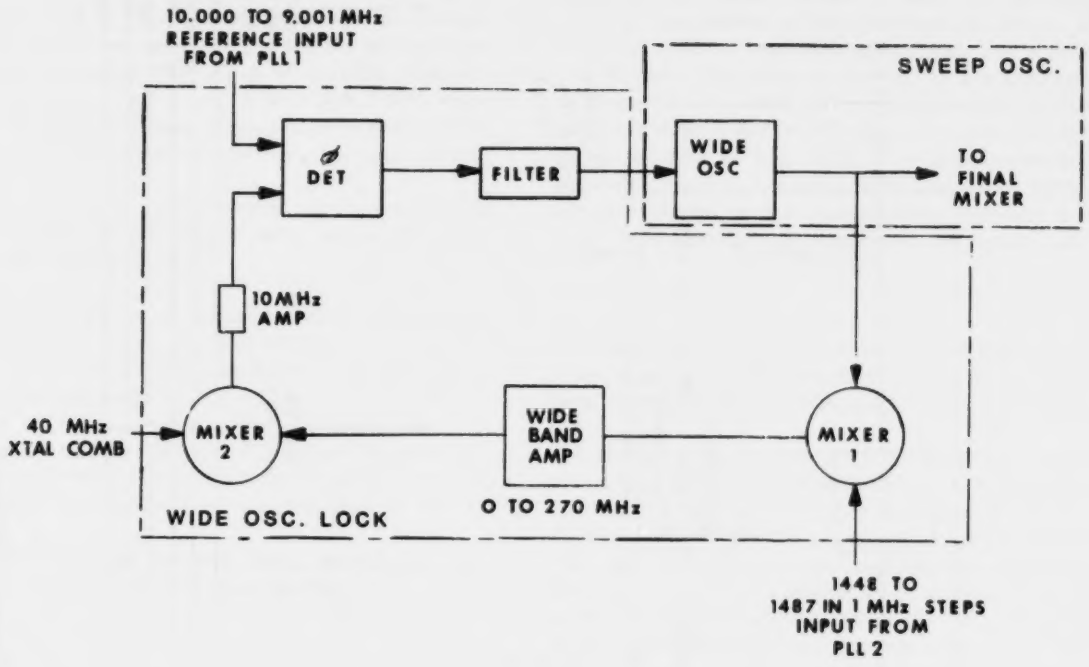


Figure 3-5a. Phase-Locked Loop 4

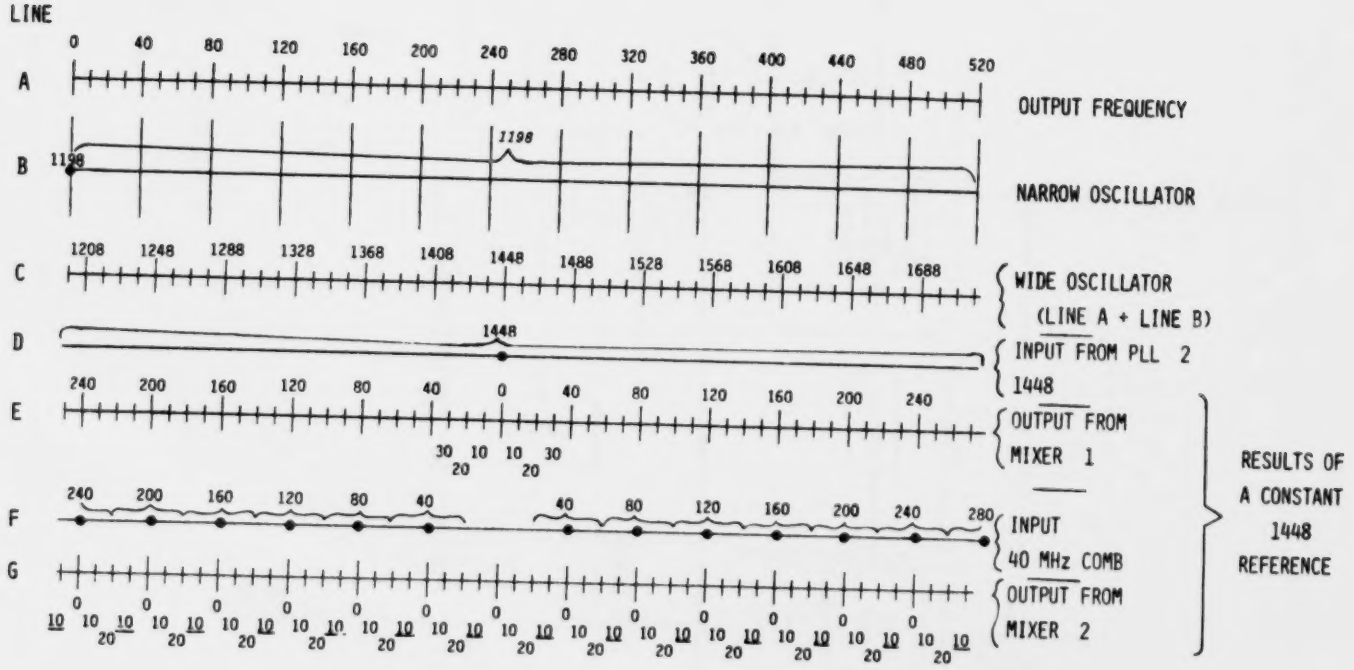


Figure 3-5b. Phase-Locked Loop 4

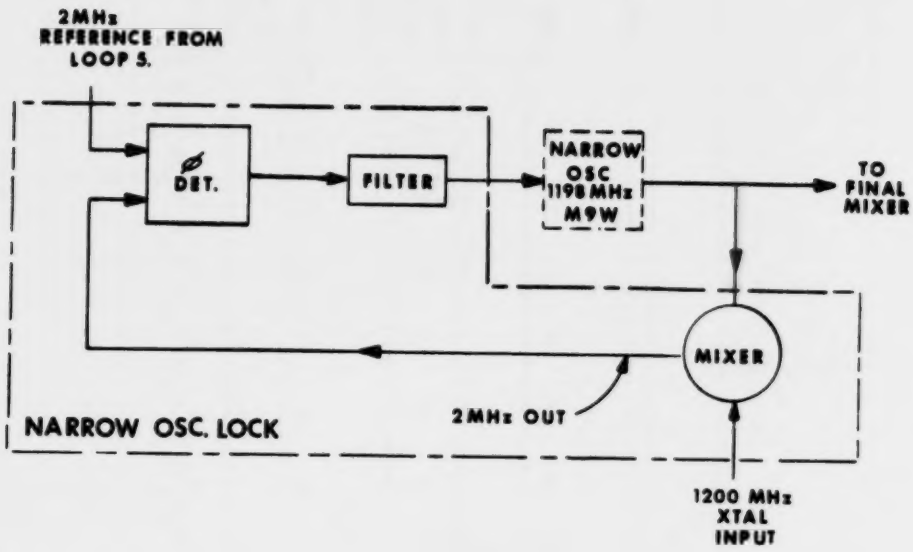


Figure 3-6. Phase-Locked Loop 5

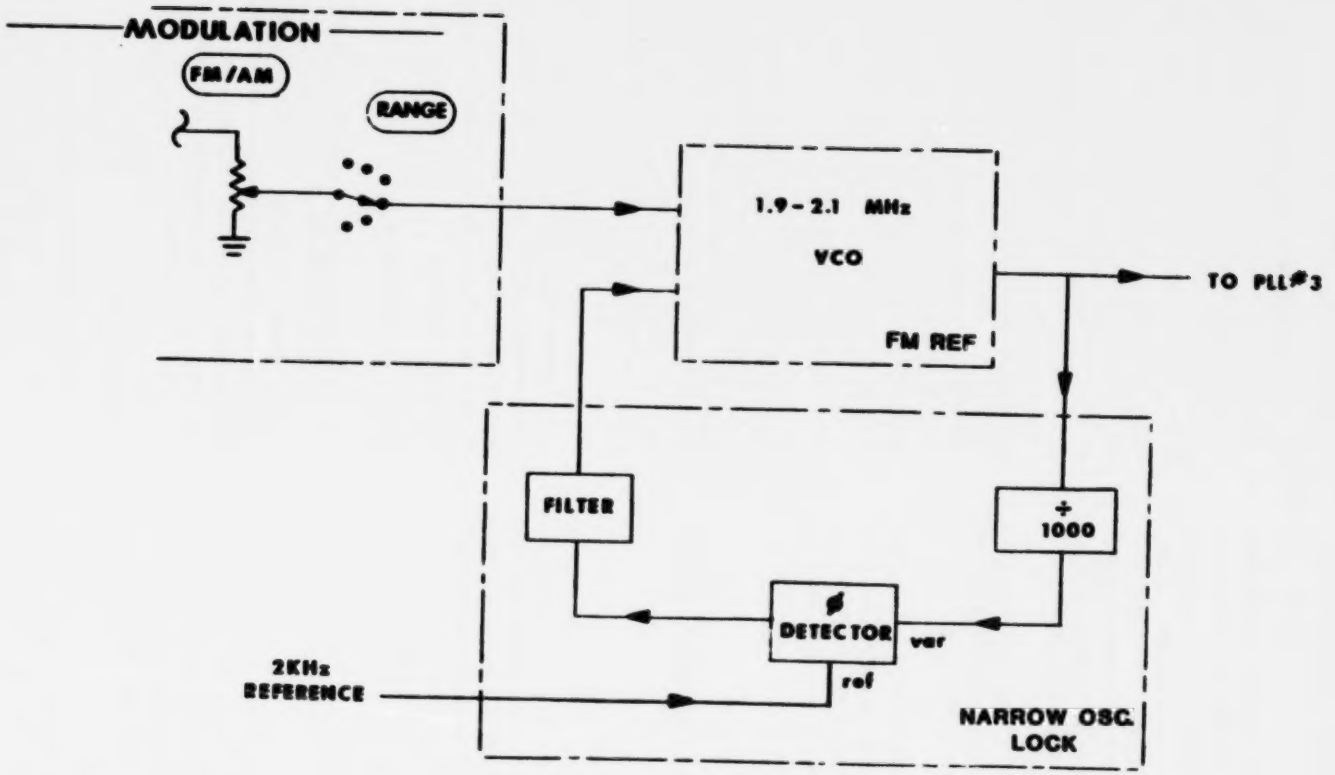


Figure 3-7. Phase-Locked Loop 5

TM11-6625-3023-14

proper frequency. Therefore, although there are 14 possible lock points on line G, the only one selected will correspond to the analog-tuned frequency of the Wide Oscillator. The unit as described so far is capable of phase-locked output at 0, 40, 80. . . 520 MHz. The following is an explanation of locking at 1 MHz intervals.

To allow phase locking at 1 MHz intervals, the reference frequency to mixer 1 is made adjustable in 1 MHz steps over a 40 MHz range (1448-1487 MHz).

If, for example, this reference frequency to mixer 1 were 1449 MHz, the input range to the phase detector would look the same except the entire range would be shifted 1 MHz to the right. Lock points would then be possible at output frequencies of 1, 41, 81 MHz, etc.

Being able to change this reference in 1 MHz steps allows phase locking from 0 to 520 MHz in 1 MHz steps.

To provide phase locking in 1 kHz steps, the PLL 4 phase detector's reference from PLL 1 is adjustable in 1 kHz steps (10.000 to 9.001 MHz). This causes the Wide Oscillator frequency to change in 1 kHz steps in order to keep the loop locked.

PLL 3

The purpose of PLL 3 is to stabilize the Narrow Oscillator at a frequency of 1198 MHz.

Figure 3-6 shows a simplified block diagram of PLL 3. This loop operates in the same manner as PLL 1 and PLL 2, except that it does not require the use of a programmable counter. The 1198 MHz output from the Narrow Oscillator is combined in a mixer with a 1200 MHz crystal controlled signal. This produces a 2 MHz difference signal. This signal is fed to a phase detector where it is compared to a 2 MHz reference. Any difference in the input signals will produce an error voltage which is applied to the Narrow Oscillator (VCO) to correct the frequency error.

PLL 5

PLL 5 supplies the reference for PLL 3 (see Fig. 3-7). Unlike a standard phase-locked loop, the VCO can be modulated. In AM and CW, the VCO is locked on 2 MHz. In the FM mode, the VCO is modulated, but the loop ignores modulation which is faster than 50 Hz; thus the center frequency remains locked.

The loop includes a voltage-controlled oscillator, a d vider for reducing the frequency from 2 MHz to 2 kHz, a phase detector, and a filter for the phase detector output. If the variable input to the phase detector deviates from the reference frequency (slower than 50 Hz), the phase detector sends an error signal to the VCO to correct the frequency.

CRYSTAL REFERENCE

All the reference frequencies for the phase-locked loops are derived from a single 40 MHz crystal source by means of appropriate multiplication or division.

3.2.3 SUBASSEMBLY DESCRIPTIONS

The overall block diagram discussed in this section describes basically how the instrument functions as a unit. The unit is made up of 12 module assemblies and three printed circuit card assemblies. These can be identified in Figure 5-6. Sections 3.3 thru 3.16 describe the operation of each subassembly. The name of the subassembly describes, to an extent, the primary function it performs.

3.3 C315 – METER BOARD

The primary function of this assembly is to provide the program voltage to the leveler circuit for the RF amplifier. It also includes the RF output level METER which appears through the instrument front panel (see Figure 3-8).

3.3.1 LEVEL PROGRAM

During CW operation of the instrument, the level program is controlled by the OUTPUT VERNIER on the front panel. The output of this control goes to two range calibration circuits which convert the voltage from the OUTPUT VERNIER to a voltage level appropriate to drive the leveler circuit in the Output Amplifier module.

The "low" circuit provides the program for all ranges of the dented power output dial except +10 dBm. At "+10", the level program is taken from the "high" circuit. The "high" level program enables the full gain capabilities of the Output Amplifier to be used when the output is not amplitude modulated.

3.3.2 MODULATION

The modulating signal from assembly C316-6 is applied to the OUTPUT VERNIER which ultimately causes the RF level to change. The leveler in the Output Amplifier does not cause the RF level to respond linearly to changes in the level program voltage. To compensate for this, a stage is included to shape the modulation signal before it is applied to the OUTPUT VERNIER.

3.3.3 METER

The front-panel METER is controlled by the level program when the METER switch is set to OUTPUT. The METER and its driver circuits are calibrated to display a reading corresponding to the actual RF level from the Output Amplifier module.

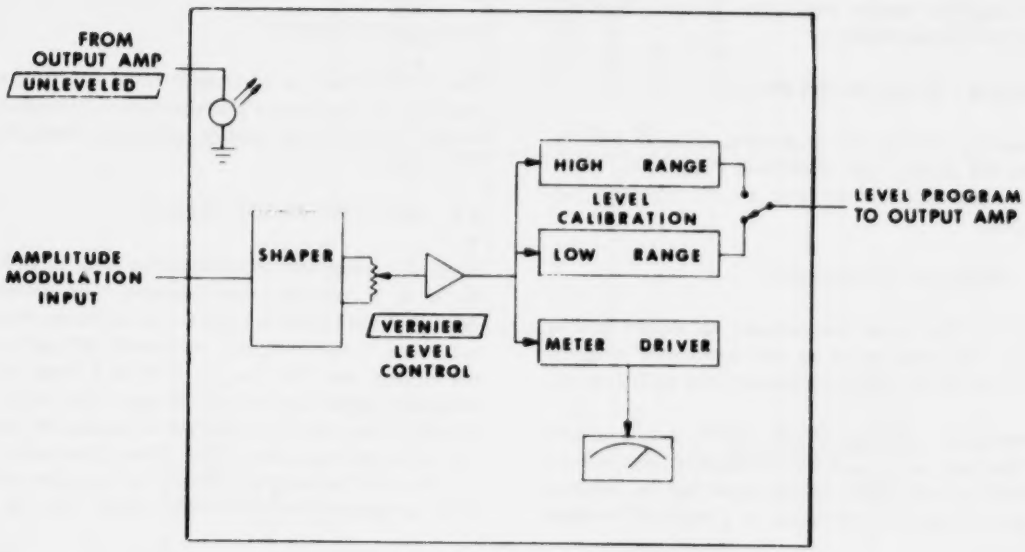


Figure 3-8. C315 Meter Board

3.3.4 UNLEVELED LIGHT

A light emitting diode is mounted on this assembly and appears on the front panel of the instrument. Refer to the Output Amplifier module description for an explanation of the circuit driving this light.

3.4 C316-6 – MODULATION BOARD

This assembly provides the modulating signals used in the AM and FM modes. The front-panel ACCURACY lights and associated circuitry are also on this assembly (see Figure 3-9).

3.4.1 MODULATING SIGNALS

The AM or FM modes are achieved by simply routing essentially the same signal to the appropriate circuitry by means of the front-panel MODULATION MODE switch.

The front-panel MODULATION FREQ switch selects one of four sources of modulating frequency, one external and three internal. The internal signal can be selected from one of two CW oscillators or a manually variable DC control.

The two internal oscillators are amplified/leveled by the same circuit for simplicity, but separately energized by the MODULATION FREQ switch. The oscillators are twin T oscillators, one is at 400 Hz, the other is at 1 kHz.

3.4.2 ACCURACY LIGHTS

The CAL switch on the FREQUENCY VERNIER determines which lamp is lit. If any of the phase-locked loops unlock, the energized LED is made to flash by an IC timer activated by a DC level from any of the phase-locked loops in the instrument.

3.5 DPS2C – POWER SUPPLY

The DPS2C provides DC power for the rest of the instrument (see Figure 3-10).

3.5.1 TRANSFORMER & FILTERS

The transformer steps down the line voltage to appropriate levels for the three circuits. Full wave rectifiers and filter capacitors convert this voltage to DC.

3.5.2 +18 V SUPPLY

The +18 V circuit has a temperature-compensated precision voltage reference. This reference is compared to the output voltage by an error amplifier which corrects any error in the output voltage.

3.5.3 -18 V SUPPLY

The -18 V circuit compares the +18 V and -18 V outputs and holds the difference in their magnitudes to zero.

3.5.4 +7.3 V SUPPLY

The +7.3 V circuit uses a three-terminal adjustable voltage regulator IC to provide a pre-regulated +7.3 V output. This voltage supplies other voltage regulators throughout the instrument.

3.6 M35-2 RF CIRCUIT BREAKER

When the instrument's POWER switch is set to OFF, relay K1 is in its normally open position. This prevents any damage to the instrument while it is not in use. As soon as AC power is applied to the instrument, IC1 will compare the voltage from RF monitor CR1 to a fixed reference voltage of approximately 5 V. As long as the output of the monitor is less than the 5 V reference voltage, the output of IC1 will be approximately +17 V. This positive output from IC1 turns on the relay driver, Q1. This energizes relay K1 thus completing the RF output circuit (see Fig. 3-11).

The positive output from IC1 also turns on Q2. This effectively grounds pin 7 of timer IC2, which is being operated as an astable oscillator. With pin 7 grounded, the timer is inoperative, and its output, pin 3, is high. The high output from IC2 turns off Q3. This prevents any current flow to the front-panel UNLEVELED light.

If an external RF signal exceeding 6 VRMS is applied to the instrument's RF output connector, the output from monitor diode CR1 will go above 5 V. This will produce a negative output from IC1. The positive feedback provided by R7 will latch IC1 in this state. The negative output from IC1 will turn off relay driver Q1. This causes relay K1 to return to its normally open position, removing the external RF signal from the instrument.

The negative output from IC1 also turns off Q2, thus removing the short on pin 7 of timer IC2. This allows the timer to operate as an astable oscillator. The output, pin 3 of IC2, then varies between 0 and 7 volts. This causes Q3, the LED driver, to supply current intermittently to the front-panel UNLEVELED light, causing it to flash.

After the RF overload is removed, IC1 can be unlatched by momentarily removing AC power from the instrument.

3.7 M9W-5 – SWEEP OSCILLATOR

The M9W-5 is the origin of the instrument's RF output frequency. This frequency is generated by heterodyning the signals from two higher frequency voltage-controlled oscillators (see Figure 3-12).

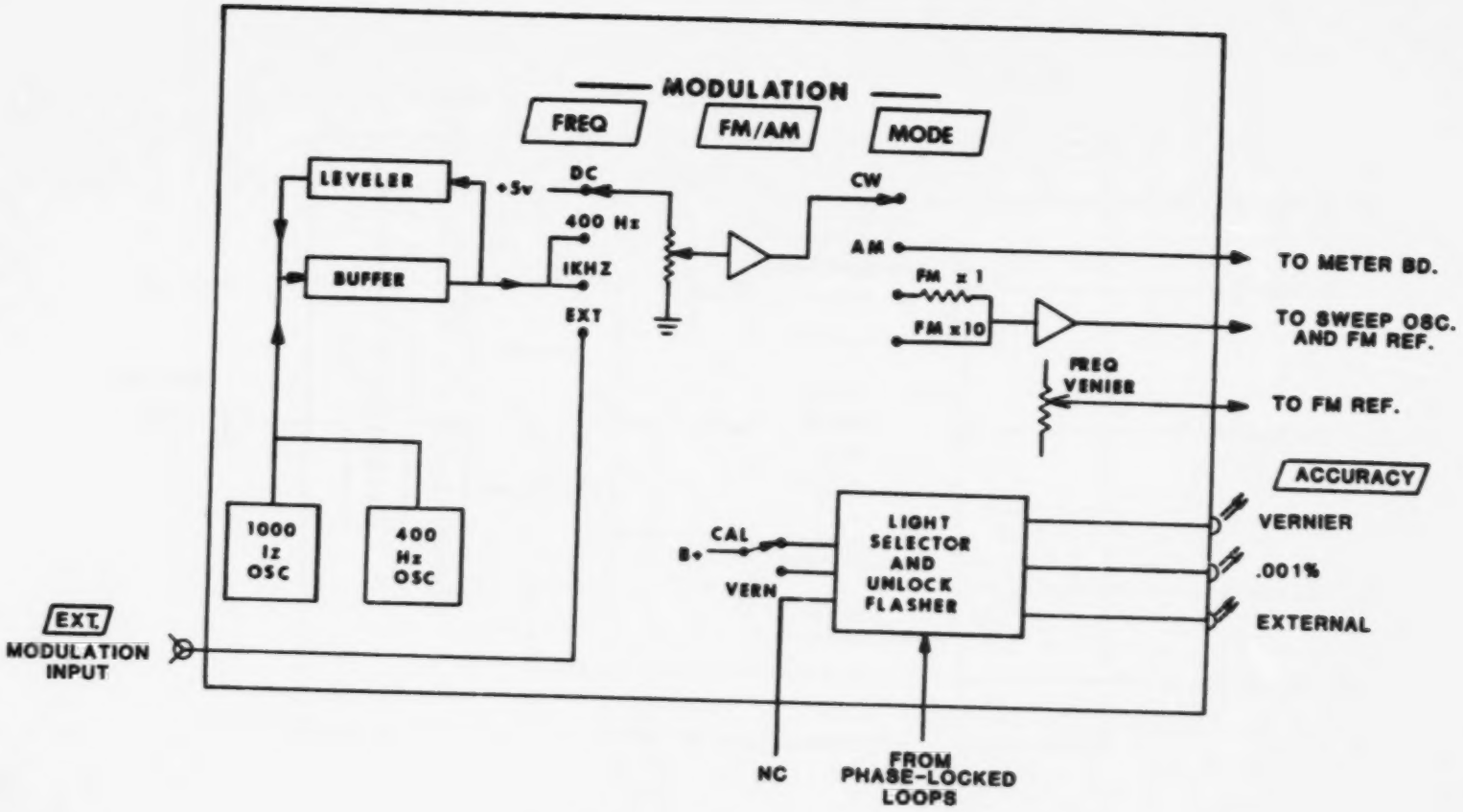


Figure 3-9. C316-6 Modulation Board

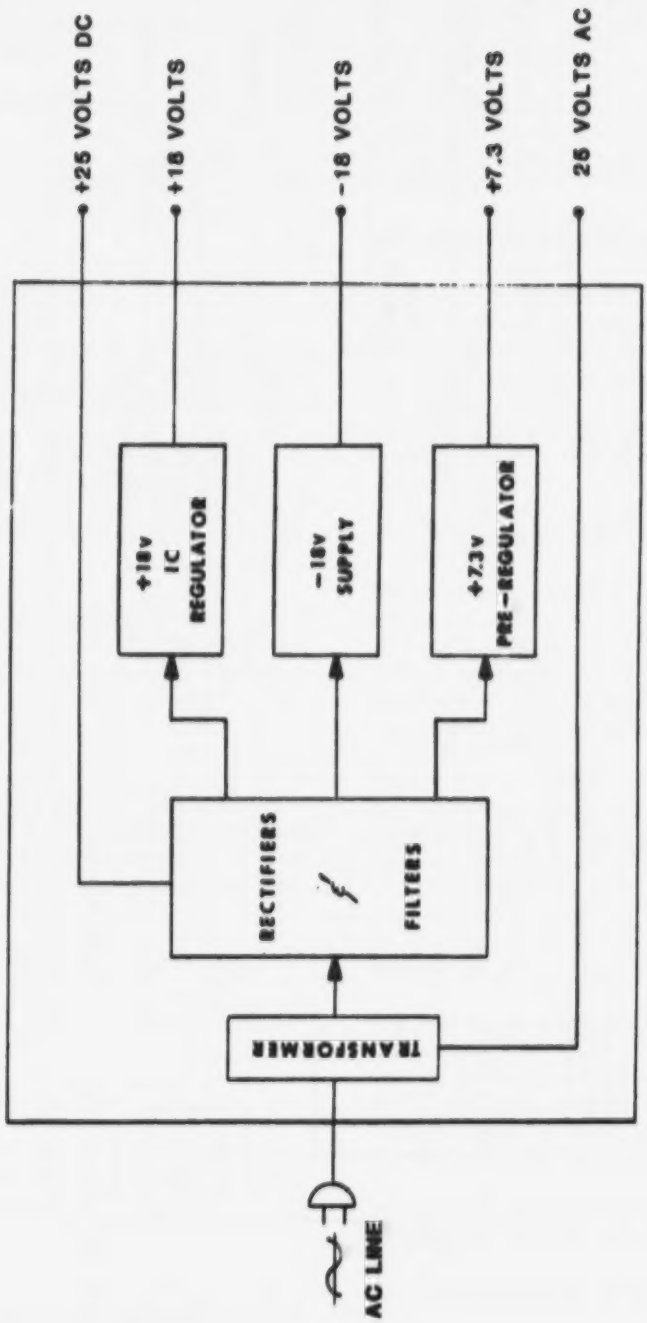


Figure 3-10. DPS2C Power Supply

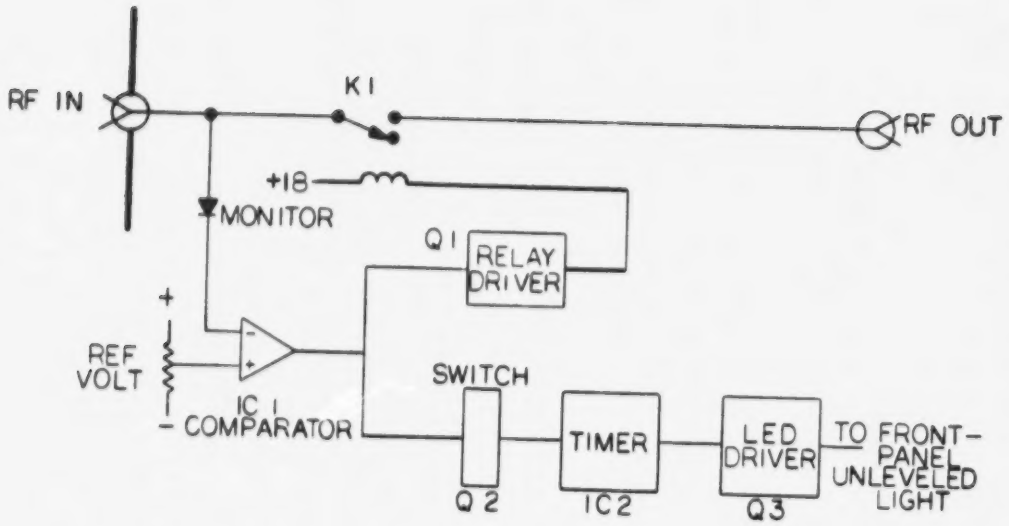


Figure 3-11. M35-2 RF Circuit Breaker

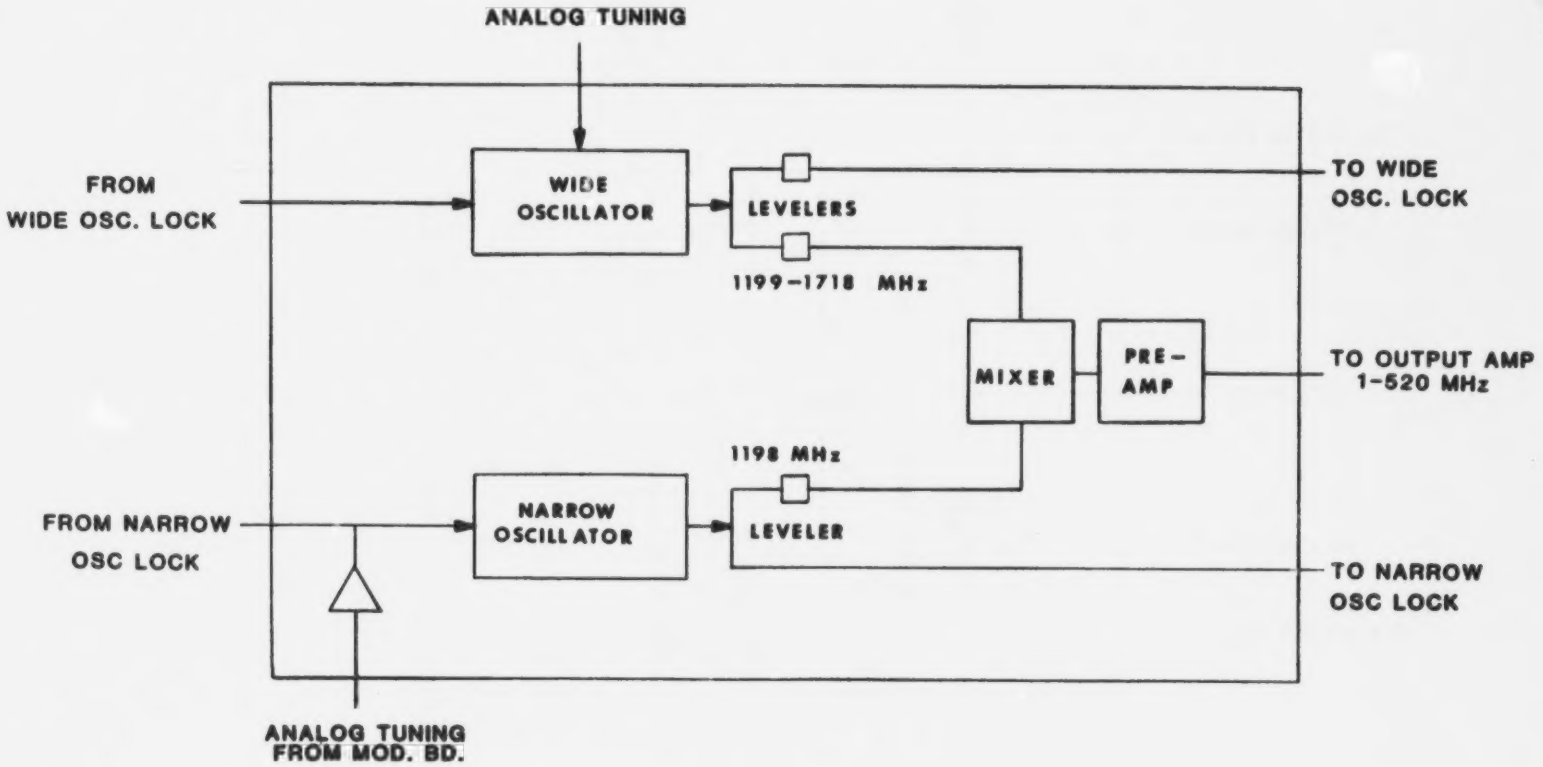


Figure 3-12. M9W-5 Sweep Oscillator

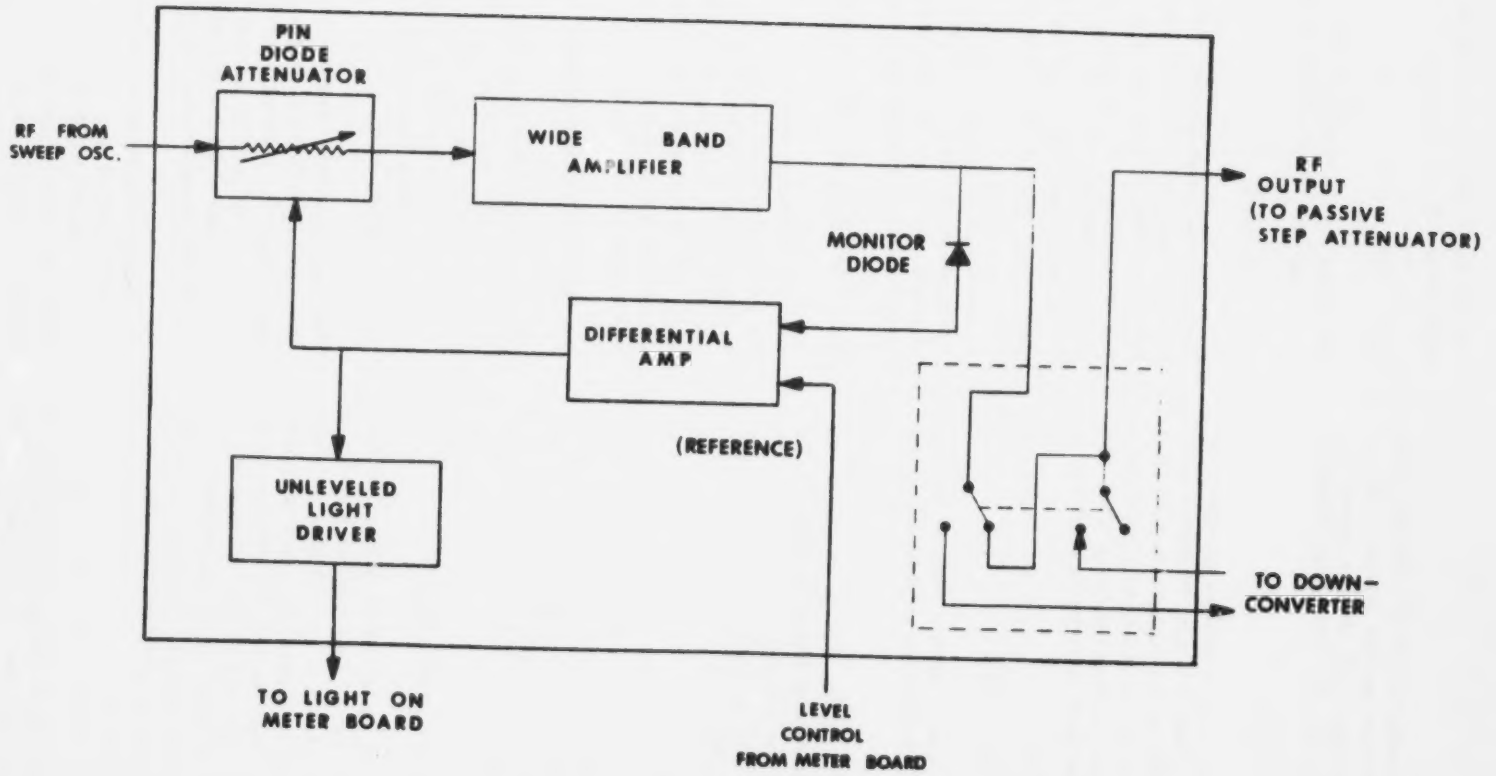


Figure 3-13. M10W-10 Output Amplifier

3.7.1 MIXER

The Narrow Oscillator applies a signal of 1198 MHz to the mixer. The Wide Oscillator provides between 1199 and 1718 MHz. The difference (1-520 MHz) is applied to a wide band pre-amp and then sent to the Output Amplifier.

3.7.2 WIDE OSCILLATOR

The wide range of oscillation is achieved by applying an analog signal which is dependent upon the setting of the Lever/Indicator switches on the instrument's front panel to varactor diodes in the tank circuit. An additional signal is applied to the VCO from the phase detector in M34-1. This is the fine tuning signal which locks the Wide Oscillator on the proper frequency.

3.7.3 NARROW OSCILLATOR

This oscillator also uses a varactor diode so that the frequency can be voltage controlled for phase locking and for FM operation.

The coarse modulating signal (FM) is applied to the varactor from the Modulation Board (C316-6). The frequency of this oscillator is further controlled by a "fine tuning" bias voltage from the M33-2 phase detector. The deviation can be controlled up to 100 kHz.

3.7.4 LEVELERS

This module contains three RF leveling circuits. These maintain a constant amplitude RF over the frequency range and with temperature variation. The output of a peak detector is compared to a constant DC level. Any error is amplified and applied to a PIN diode attenuator in series with the RF signal.

3.8 M10W-10 – OUTPUT AMPLIFIER

The main function of the M10W-10 Output Amplifier module is to amplify the RF signal from the M9W-5 to a level programmable between -7 and +13 dBm. A leveler circuit maintains a constant amplitude output signal over the wide frequency range. The UNLEVELED light driver causes the front-panel light to glow when the leveler circuit exceeds its proper operating range. The M10W-10 also contains a switch which routes the RF output to either the Step Attenuator or Down Converter (see Fig. 3-13).

3.8.1 SWITCH

The switch is normally set to route the output signal to the Step Attenuator; however, when the front-panel "MHz" Lever/Indicator switches are set to "000.", the logic signal from the M115 into pin 5 of the M10W-10 triggers the switch (relay K1) and routes the RF signal to the M115.

3.8.2 AMPLIFIER

This section is a four-transistor, wide band amplifier which can increase the RF level by about 23 dB.

3.8.3 LEVELER

The leveler uses a peak detector, differential amplifier, and PIN diode attenuator. The peak detector is fed from the RF output. The resulting level is compared to a DC (or AM) reference by the differential amp which supplies the control current to the PIN diode attenuator. If the detected RF output deviates from the reference level, the signal to the PIN diode causes the input to be decreased or increased.

In addition to providing a flat frequency response, the leveler allows for electronic control of the RF output amplitude by varying the DC reference. The reference comes from the Meter Board (C315).

3.8.4 UNLEVELED LIGHT DRIVER

When the differential amp in the leveler circuit is putting out a voltage which would cause the PIN diode attenuator to be at its high or low resistance limit, the leveling circuit can no longer be effective. These extreme voltage levels, which are applied to the UNLEVELED light driver, are adequate to turn on a source of current for the indicator which appears through the front panel.

3.9 M172 SWEEP DRIVE/DAC

This module provides two output voltages. One is linear from 0 V to -5 V as the frequency goes from 0 to 39 MHz, repeating every 40 MHz; the other varies from +7 V to -8 V as the frequency goes from 0 to 520 MHz. The second voltage is shaped to linearize the VCO in the M9W-5 Sweep Oscillator (see Fig. 3-14).

Two digital-to-analog converter ICs, programmed by the front-panel Lever/Indicator switches, provide the 0 to 520 MHz voltage. This is shaped in the next section of the module. A third DAC provides the repeating 0 - 40 MHz voltage. Since the state of the 20's line depends on the 100's line, the 20's line is inverted when the 100's line is high.

The analog tuning signal from the M172 is "shaped" before driving the M9W-5 wide oscillator. The shaper is an inverting DC amplifier which amplifies the input by a smaller factor for smaller magnitude inputs. Shaping this analog voltage compensates for the non-linear change in capacitance of the varactor diodes in the M9W-5 oscillator circuit.

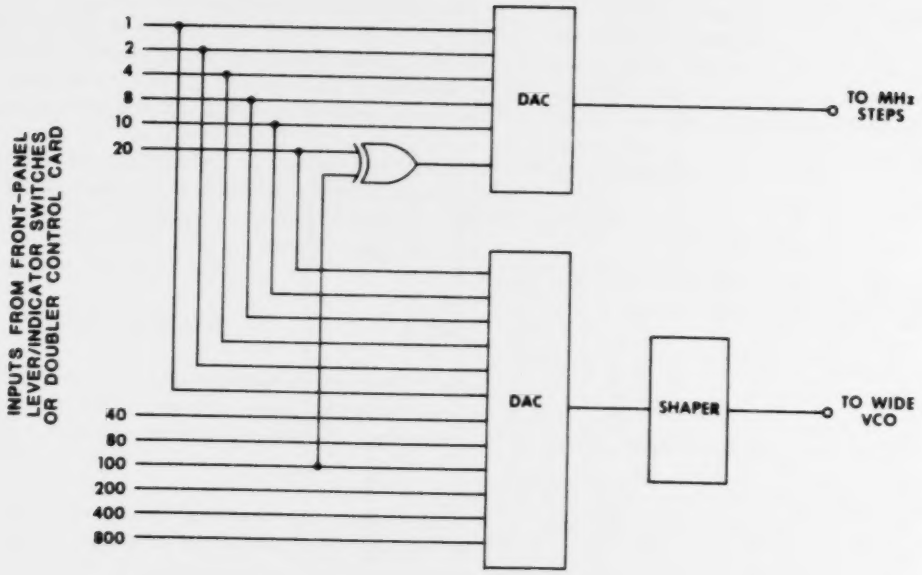


Figure 3-14. M172 Sweep Drive/DAC

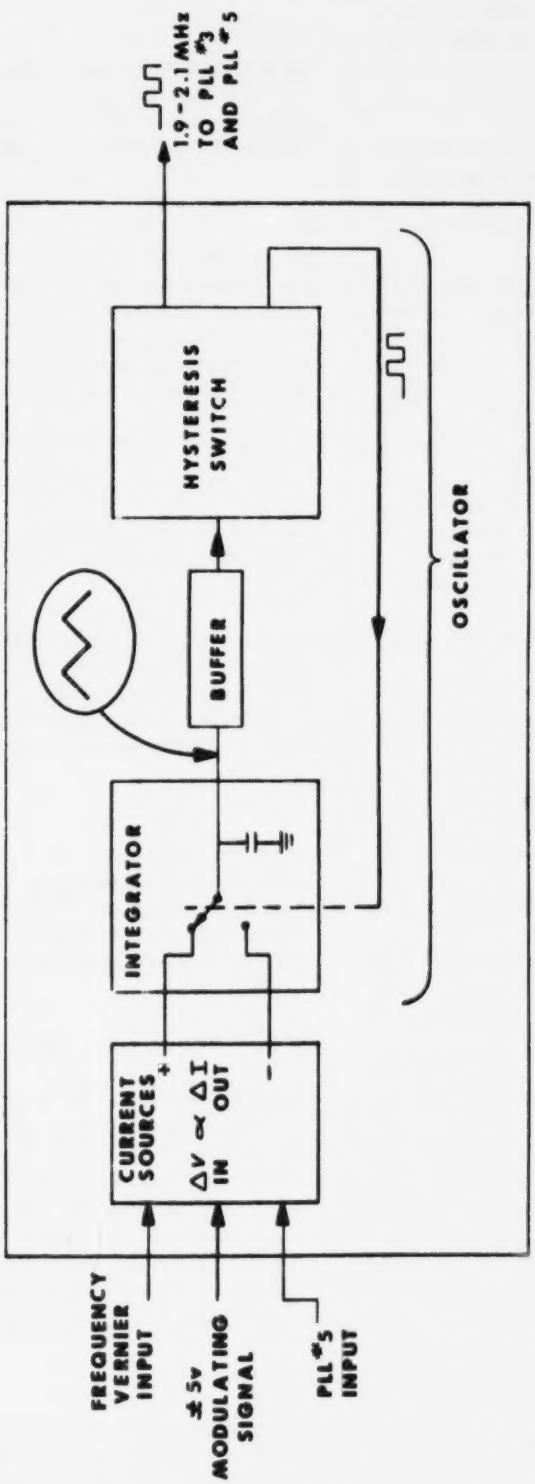


Figure 3-15. M29-2 FM Reference

3.10 M29-2 – FM REFERENCE

The M29-2 is a voltage to frequency converter, the output of which is used as a phase lock reference in the M33-2. The module includes a voltage variable current source which feeds (determines the frequency of) a square wave oscillator (see Figure 3-15). Zero volts in yields 2 MHz out.

The M29-2 is the VCO for PLL 5. The input to the M29-2 from the phase detector is essentially added to the modulation input. The FREQUENCY VERNIER voltage is also added here. (The FREQUENCY VERNIER input becomes zero volts when the VCO is locked).

3.10.1 CURRENT SOURCES

This circuit provides both a positive and a negative source of current. The positive source is referenced to the negative source so that the instantaneous currents in both sources are equal.

The change in output current is directly proportional to the change in input voltage to the circuit. The input voltage may vary between -5 and +5 volts. The circuit is designed for a very linear graph of current out vs. voltage in.

3.10.2 OSCILLATOR

The square wave output is produced by the combination of an integrator and a hysteresis switch. The integrator converts a square wave to a triangle wave. The triangle wave causes the hysteresis switch to produce the square wave which is fed back to the integrator.

The integrator is made up of a current switch and a capacitor. The square wave applied to the current switch causes a square current signal to be applied to the capacitor.

Positive constant current produces an increasing voltage ramp on the capacitor and negative constant current produces a decreasing voltage ramp. For a square wave input, therefore, the output is a triangle wave.

Changing the magnitude of the "currents", by changing the input voltage to the module, changes the rate at which the capacitor charges and discharges to the hysteresis points, thus changing the frequency of oscillation.

3.11 M30-8 – CRYSTAL REFERENCE

This module supplies reference frequencies at 1 kHz, 2 kHz, 1 MHz, 10 MHz, 40 MHz and its harmonics, 1200 MHz (from a 120 MHz comb), and 1440 MHz to the phase-locked loops in the instrument. These signals are produced by a 40 MHz crystal oscillator and a series of dividers and multipliers (see Figure 3-16).

3.11.1 40 MHz OSCILLATOR

This crystal oscillator is the heart of the accuracy of the frequency determining circuits in the instrument. It is temperature compensated for frequency stability. A varactor diode is included to enable this oscillator to be phase locked to a high stability reference. A leveler circuit causes the oscillator output level to be the same in all M30-1 modules.

3.11.2 DIVIDERS

The frequencies below 40 MHz are produced by a series of TTL counters as shown in Figure 3-16.

3.11.3 MULTIPLIERS

The 40 MHz CW is fed to a harmonic generator which produces the "comb" output.

From the 40 MHz comb, 120 MHz is selected and applied to another harmonic generator. A sample of the 120 MHz comb output is also fed to a filter which provides the 1440 MHz output.

3.12 M31A - kHz STEPS

The input to this module is the BCD data from the front-panel "kHz" switches (to the right of the decimal point). The output frequency is (10 MHz – Sk kHz), where Sk is the number indicated by the kHz switches. If the frequency is set to 428.333 MHz, for example, the M31A output is 9.667 MHz. The block diagram of the M31A is shown in Figure 3-17.

3.12.1 VCO

The output frequency is generated by a voltage-controlled oscillator which is tuneable from 9.001 to 10.000 MHz.

3.12.2 PHASE-LOCKED LOOP

Including the VCO in a phase-locked loop permits accurate programmability. The VCO tuning voltage comes from the phase/frequency detector circuit. A 1 kHz signal from the Crystal Reference is applied to one input of the phase detector (IC9). A sample of the VCO output is divided by the programmable divider, and the result is applied to the other input of the phase detector. Any difference in phase or frequency in the signals applied to the phase detector inputs produces an error voltage at the phase detector output, which controls the VCO. The system is stable only when the phase and frequency error is zero, so that the

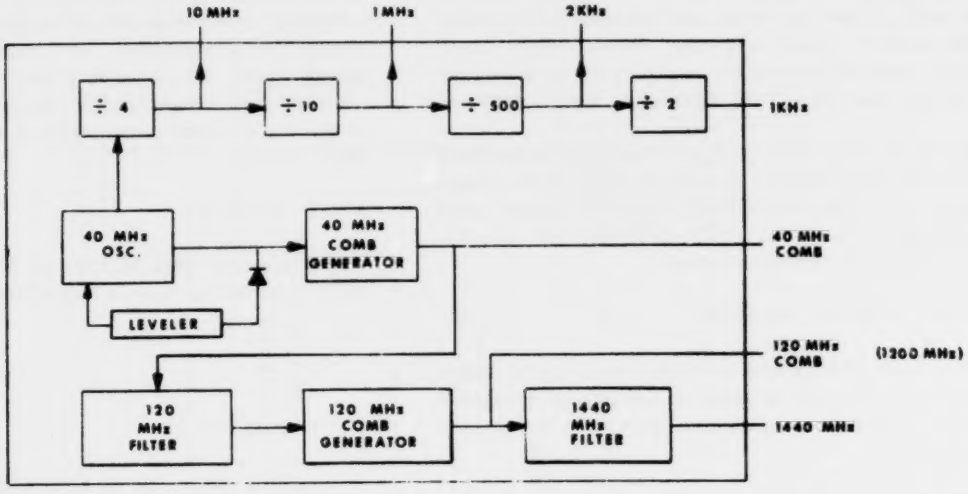


Figure 3-16. M30-8 Crystal Reference

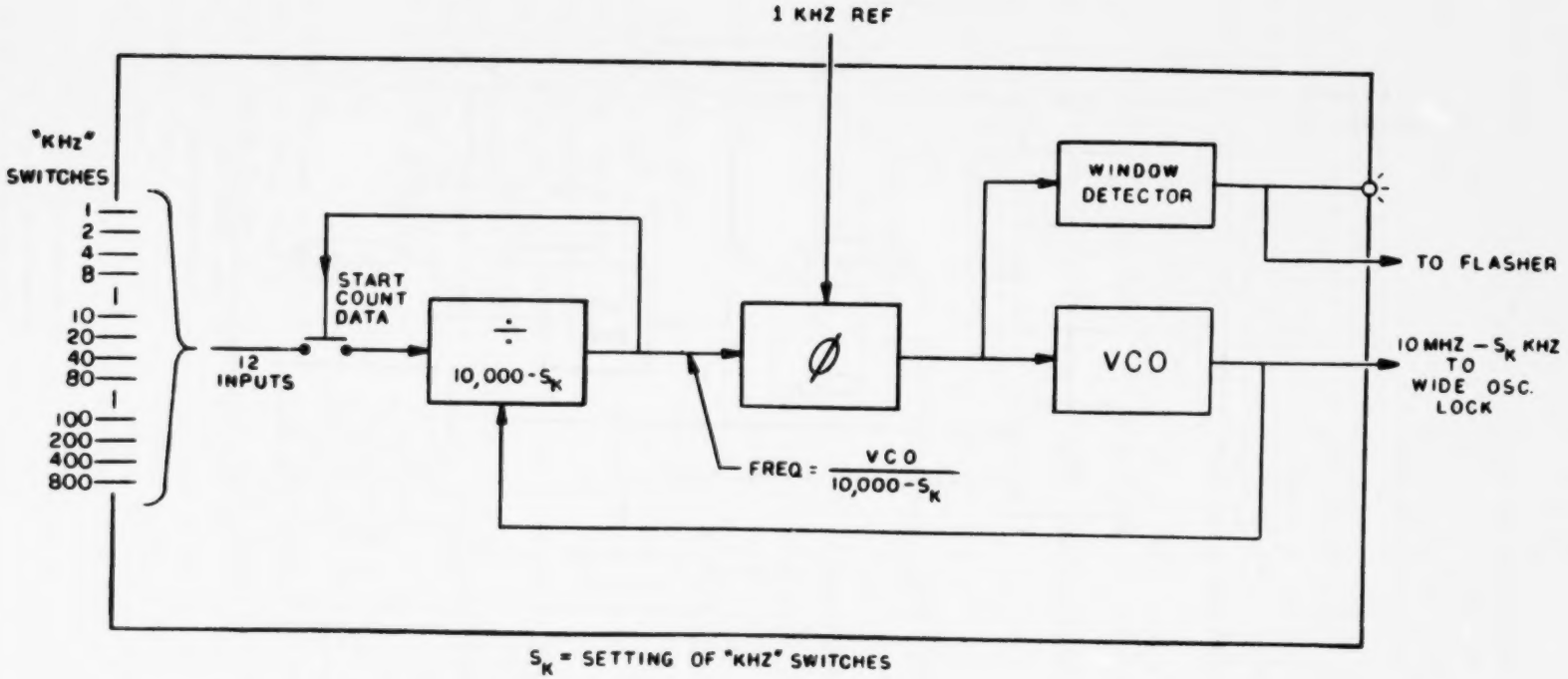


Figure 3-17. M31A kHz Steps

TM11-6625-3025-14

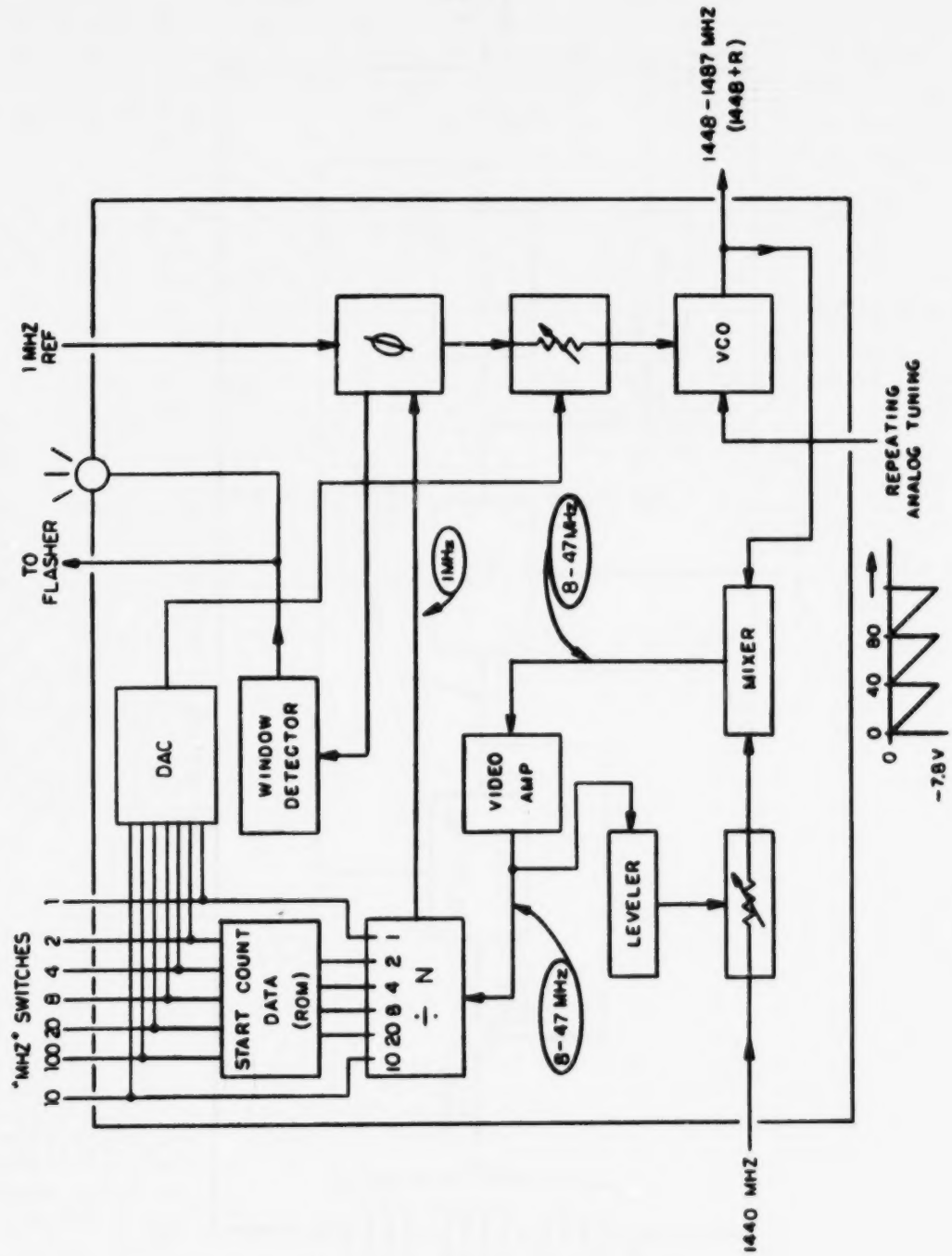


Figure 3-18. M32A-2 MHz Steps

output frequency is phase locked to the 1 kHz reference signal.

3.12.3 PROGRAMMABLE DIVIDER

In order for the M31A to perform properly, the divider is designed to divide the VCO frequency by (10,000 – Sk) where Sk is the number set on the "kHz" switches. The divider counts the number of cycles at its input and puts out a pulse when the count reaches 10,000. The starting count is the number shown on the "kHz" switches. For example, if the instrument is set for 222.500 MHz, this circuit would divide by 9,500 (count from 500 to 10,000). Therefore, the variable input to the phase detector would be correct (1 kHz) only if the VCO output were 9,500 MHz.

3.12.4 UNLOCK INDICATOR

When the phase-locked loop is unlocked, the LED on top of the module will light and the front-panel ACCURACY lights will flash.

A window detector monitors the voltage level which is being fed from the phase detector to the VCO. If the voltage exceeds the normal operating range, power is applied to the module light and the flasher circuit on the Modulation Board.

3.13 M32A-2 – MHz STEPS

The M32A-2 provides, for the M34-1, a reference frequency which corresponds to the setting on the "MHz" switches (see Figure 3-18). The M32A-2 output range is 1448 to 1487 MHz, and repeats itself with every 40 MHz change of the "MHz" switch setting. Any specific M32A-2 output relates to the "MHz" switch setting (Sm) by the equation (Output = (1448 + R) MHz), where R is the Remainder of dividing Sm by 40. If the front-panel Lever/Indicator switches are set, for example, to 333.000, R would be 13 (333 ÷ 40 = 8 with a Remainder of 13). The output of the M32A-2 would then be 1448 + 13 = 1461 MHz.

3.13.1 VCO

The output of the M32A-2 is produced by a voltage controlled oscillator. This VCO is coarsely tuned by the repeating analog output of the M172. Fine tuning is the result of including the VCO in a phase-locked loop. In addition to the VCO, the phase-locked loop includes a phase detector and programmable divider.

3.13.2 PROGRAMMABLE DIVIDER

A sample of the VCO output is mixed with the 1440 MHz signal from the Crystal Reference producing a difference frequency of from 8 to 47 MHz, which is then shaped into TTL pulses and applied to the programmable divider.

The divider counts the falling edges of the 8-47 MHz input pulses, resetting each time a count of 47 is reached. The reset pulse is applied to one input of the phase detector. By controlling the starting count of the programmable divider, the effective divisor can be controlled.

The starting count of the programmable divider is selected by a read only memory, which is programmed to provide the correct "R" information for each "Sm" setting. This "R" is then applied to the programmable divider as the starting count. Thus, as the starting count varies from 0 to 39, the effective divisor varies from 47 to 8.

When the VCO is running at the correct frequency, the programmable divider reset pulse rate will be 1 MHz.

3.13.3 PHASE DETECTOR

One input to the phase detector is the reset pulse from the programmable divider. The other input is a 1 MHz fixed reference signal from the Crystal Reference. The phase detector output is a voltage determined by the difference in phase at the phase detector inputs, and is used to correct any error in the VCO frequency or phase.

If the VCO output frequency is too high, for example, the phase detector output becomes more negative, thus increasing the VCO varactor diode tuning capacitance and lowering the VCO frequency. If the VCO frequency is too low, the reverse occurs. Thus, the loop will tend to maintain zero phase or frequency error. A voltage-controlled attenuator between the phase detector circuit and the VCO keeps the open-loop gain of the phase-locked loop relatively constant over the programmed frequency range, allowing the loop noise to be minimized.

3.13.4 UNLOCKED INDICATOR

When the phase-locked loop is unlocked, the LED on top of the module will light and the front-panel ACCURACY lights will flash.

A window detector monitors the voltage level being fed from the phase detector to the VCO. If the voltage exceeds the normal operating range, power is applied to the module light and the flasher circuit on the Modulation Board.

3.14 M33-2 – NARROW OSCILLATOR LOCK

The M33-2 contains the circuits to phase lock the Narrow Oscillator in the M9W-5 (PLL 3) and the M29-2 FM Reference (PLL 5). As explained in Section 3.2.2, PLL 5 provides the reference frequency for PLL 3 (see Fig. 3-19).

3.14.1 PHASE DETECTOR FOR PLL 3

This circuit compares the reference frequency to the variable frequency representing the M9W-5 VCO output.

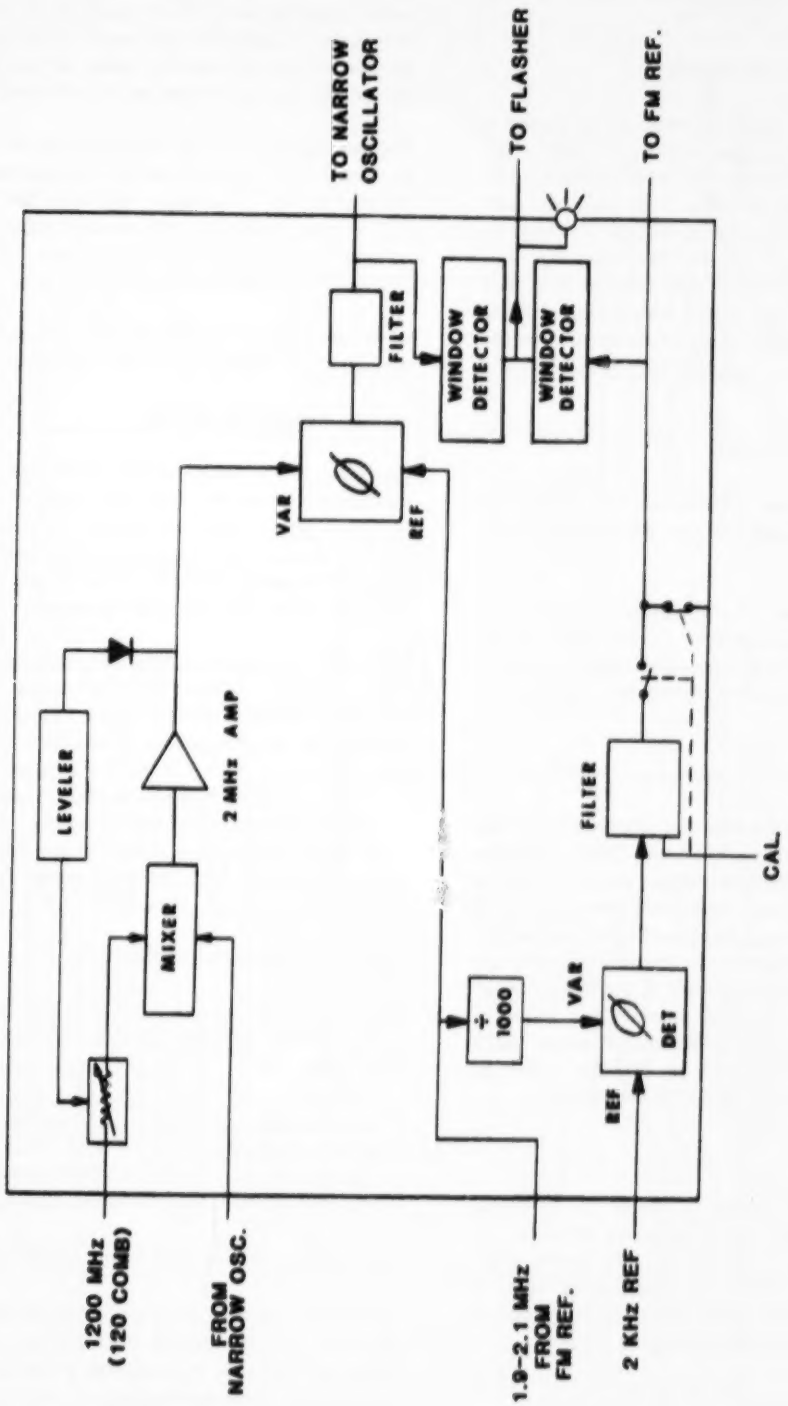


Figure 3-19. M33-2 Narrow Oscillator Lock

If the VCO is too high, for example, the phase detector puts out a more positive voltage which is filtered and inverted by an integrator and applied to the VCO (Narrow Oscillator) to lower the frequency.

3.14.2 MIXER

The phase detector cannot operate at UHF frequencies, so the VCO is mixed with 1200 MHz CW. This provides an offset frequency which is the variable input to the phase detector. The deviation of this variable signal from 2 MHz is precisely the same as the deviation of the VCO from 1198 MHz.

3.14.3 PHASE DETECTOR FOR PLL 5

This circuit compares the 2 kHz reference from the M30-1 to the variable frequency which is the M29-2 output divided by 1000 so that even when the M29-2 is frequency modulated, the variable frequency will remain in the capture range of the phase detector. Any frequency modulation (above 50 Hz) is filtered out by the integrator filter and the error voltage is fed to the M29-2.

3.14.4 UNLOCK INDICATOR

Window detectors are fed by the integrator outputs. If the integrators put out a voltage outside their normal operating range, the window detectors apply voltage to the module's unlock indicator and to the flasher circuit on the Modulation Board.

3.15 M34-1 WIDE OSCILLATOR LOCK

This module provides the fine tuning program for the Wide VCO in the M9W-5. Figure 3-20 is the block diagram of the M34-1. The letters A through F relate the signals at the associated points in the module to the graphs A thru F in Figures 3-21 and 3-22. The M34 phase locks the VCO to 1198 MHz plus the frequency indicated on all six front-panel switches. The frequency offset circuit converts the frequency of the VCO to a lower frequency which retains the frequency error information for use by the phase detector. In addition to the frequency offset circuit and the phase detector, several auxiliary circuits are included.

3.15.1 PHASE DETECTOR

The phase detector compares the "offset" VCO frequency to the reference frequency from the M31A. (Refer to the description of the M31A for a more detailed description of this 10.000 - 9.001 MHz reference.)

The phase detector output voltage goes positive or negative to ultimately drive the Wide Oscillator higher or lower in frequency until both inputs to the phase detector are the same frequency. The integrator serves as a low pass filter for the phase detector.

3.15.2 FREQUENCY OFFSET CIRCUIT

The VCO error information must be converted to a frequency useable by the phase detector. This conversion is made by mixer 1, a 270 MHz low pass filter, mixer 2, and a 10 MHz low pass filter. Refer to Figures 3-20, 3-21, and 3-22 for descriptions of signals.

Mixer 1 heterodynes the VCO frequency with the "MHz steps" reference frequency (1448 + R MHz). The difference frequency, | 1448 + R – VCO |, is below 270 MHz. This signal is sent to mixer 2 where it is heterodyned with the 40 MHz comb. For any output frequency, graph D in Figure 3-21 shows only the comb frequency which will yield the desired output (below 20 MHz) of mixer 2. If the loop is locked, mixer 2 will produce a 10 MHz difference as shown in Figure 3-21 (assuming the "kHz" switches are set for 000). Figure 3-22 shows signals A thru F for a case when the kHz switches are not 000.

The filter after mixer 2 blocks all the outputs of the mixer except the lower frequency signal containing the VCO error information. When the unit is unlocked, the filter passes up to 20 MHz (to be able to capture over the 20 MHz range allowed for analog tuning). Once the loop is locked, the filter decreases to 10 MHz to further eliminate phase-locked loop-related spurious signals.

3.15.3 AUXILIARY CIRCUITS

The "speed-up circuit" is activated when the phase-locked loop becomes unlocked. The output of this circuit is sent to the M9W-5 to cause the VCO to be tuned faster by the analog voltage.

The "unlock" amp monitors both the tuning voltage from the phase detector and the leveler voltage to detect an unlocked condition of the M34. When unlock occurs it sends a voltage to the flasher circuit.

The leveler circuit maintains a constant input amplitude to the phase detector by controlling the amplitude of the input from the M9W-5 Wide Oscillator. The input to the phase detector (about 10 MHz) is peak detected and compared to a DC reference in the leveler circuit. The leveler circuit controls a PIN diode attenuator which is between the VCO input and mixer 1.

3.16 M11S – DOWN-CONVERTER (MODEL 3001-608)

This module takes the RF output from the M10W-10 (when the front-panel "MHz" selector switches are set to "000.") and converts it to the proper 1 to 999 kHz output frequency (see Fig. 3-23).

The BCD signals from the front-panel "MHz" selector switches are fed into a 13-input NAND gate. (Two of the inputs are held high.) This gate determines whether the

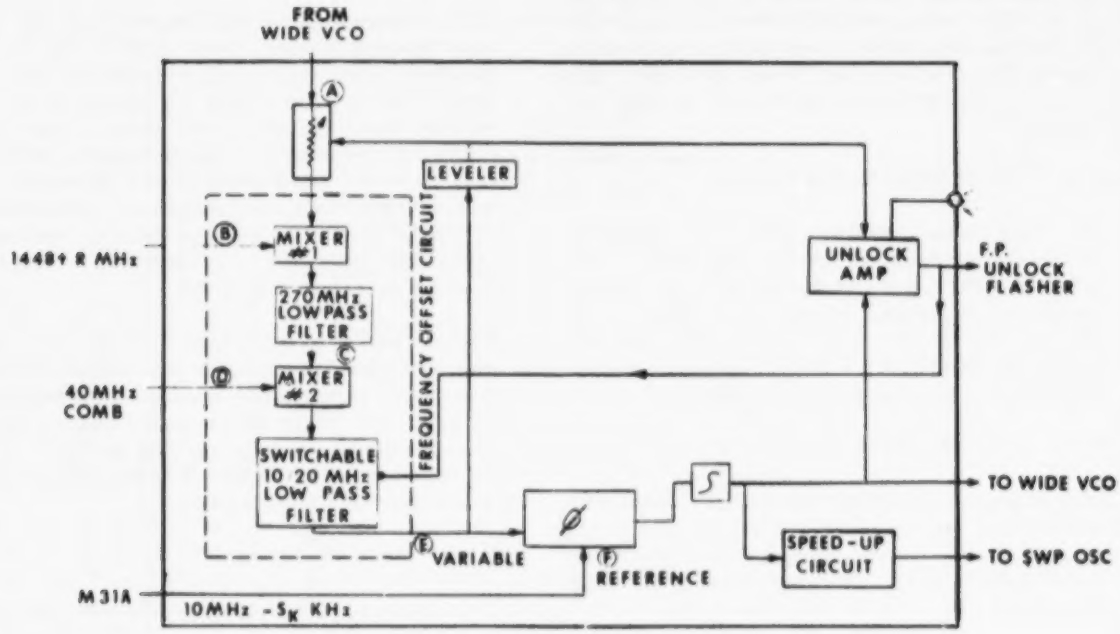


Figure 3-20. M34-1 Wide Oscillator Lock

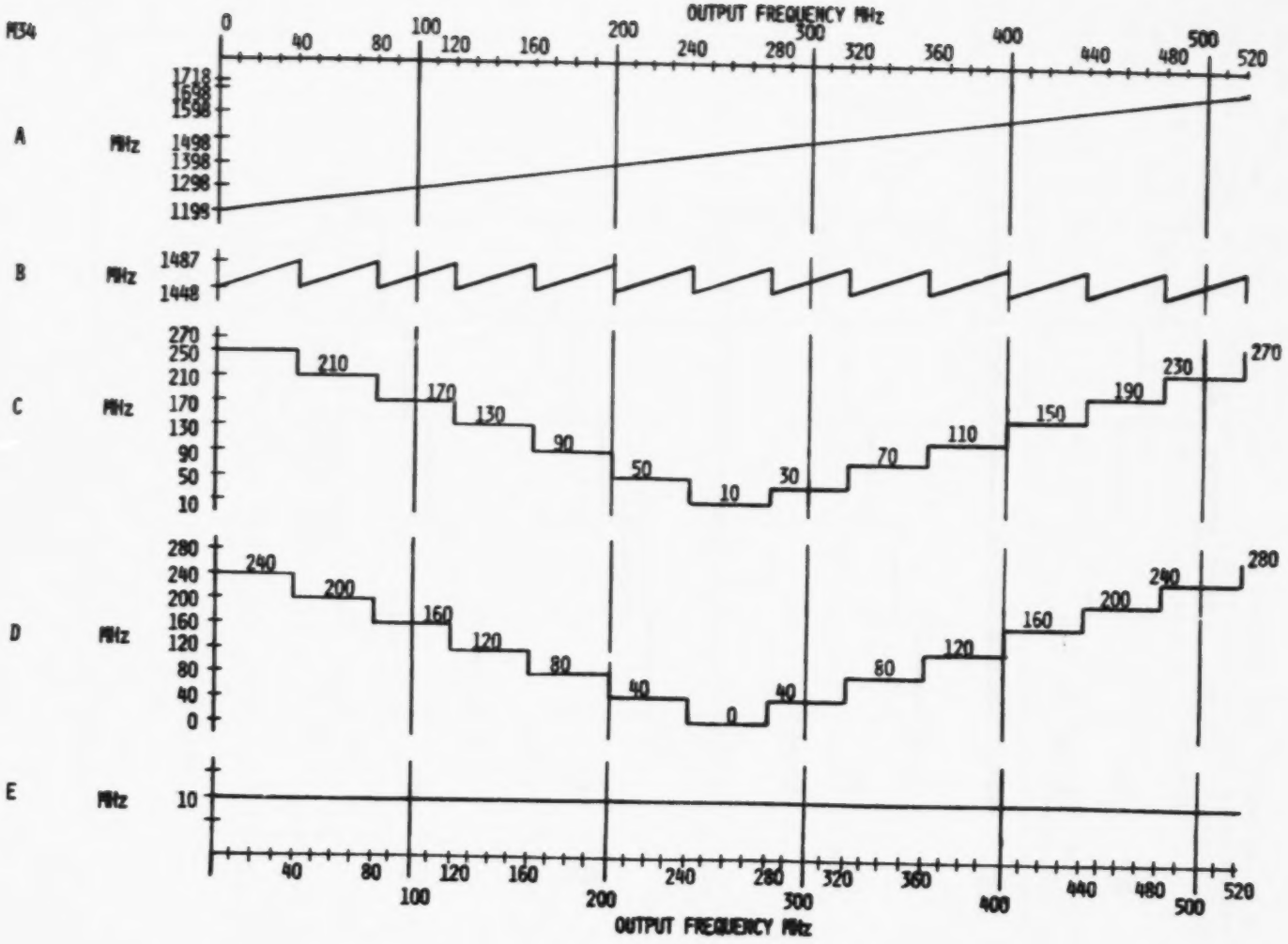


Figure 3-21. M34-1 Frequencies

TM11-6625-3039-14

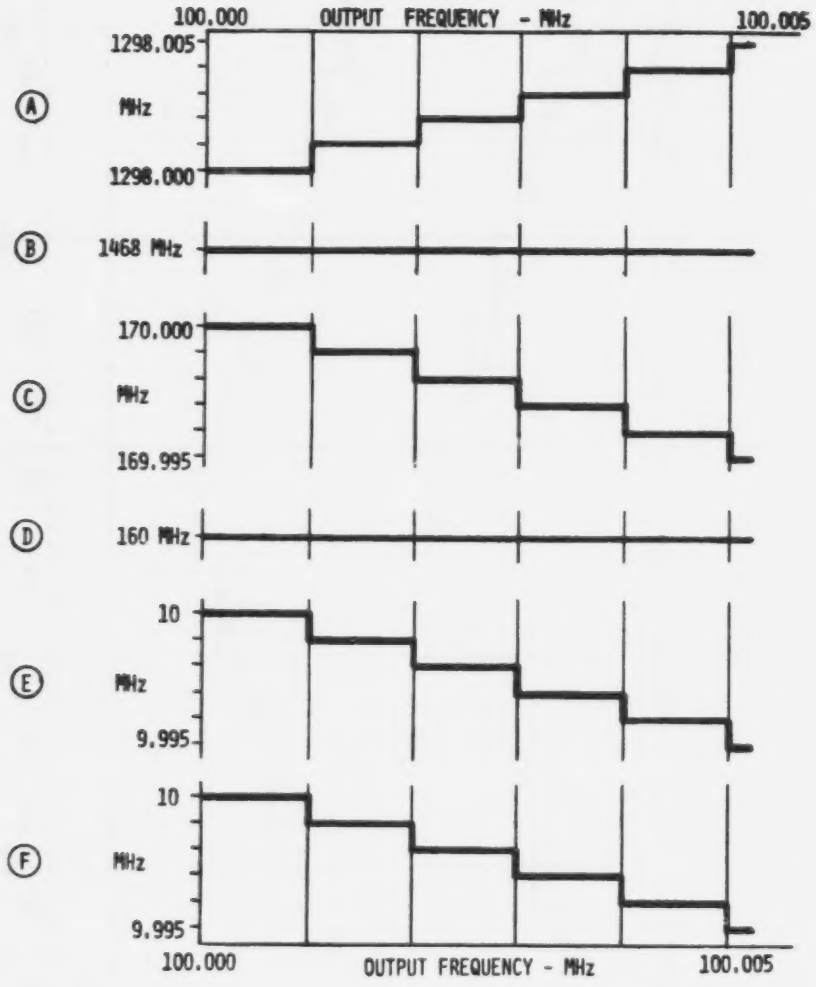


Figure 3-22. M34-1 Frequencies (Expanded)

switches are set for "000.", and, if so, triggers a hex inverter to send out a logic "true" to the M10W-10 and activates the 10 MHz line to the M172 and M32A-2. This programs the M9W-5 for 10 MHz plus the "kHz" switch setting, and this signal is fed into the M10W-10. At this point, however, the signal is routed to the M115 (see Section 3.8), where it is mixed with the 10 MHz reference signal from the M30-8 Crystal Reference. The difference frequency from this mixing is simply the "kHz" switch setting, and is output back to the M10W-10 and on to the Step Attenuator.

The M115 also contains a 20 dB attenuation pad for the input from the M10W-10, and an RF amplifier for the 10 MHz reference signal. The effect of these stages is to allow the mixer output to be directly proportional to the output from the M10W-10. The mixer output is then fed into a 3-stage amplifier with complimentary push-pull output to restore the output to the proper (-7 to +13 dBm) level. Potentiometer R3 and trimcap C20 fine adjust the gain and frequency response of the module.

If the front-panel "MHz" switches are not set to "000.", the M115 has no function except that the 10 MHz program line from the switches to the M172 and M32A-2 passes through the M115.

NOTE

If the M115 is removed for servicing, the instrument may still be used; however, the frequency range is reduced to 1-520 MHz. In this case, pins 1 and 9 of the M115 module socket must be jumpered together.

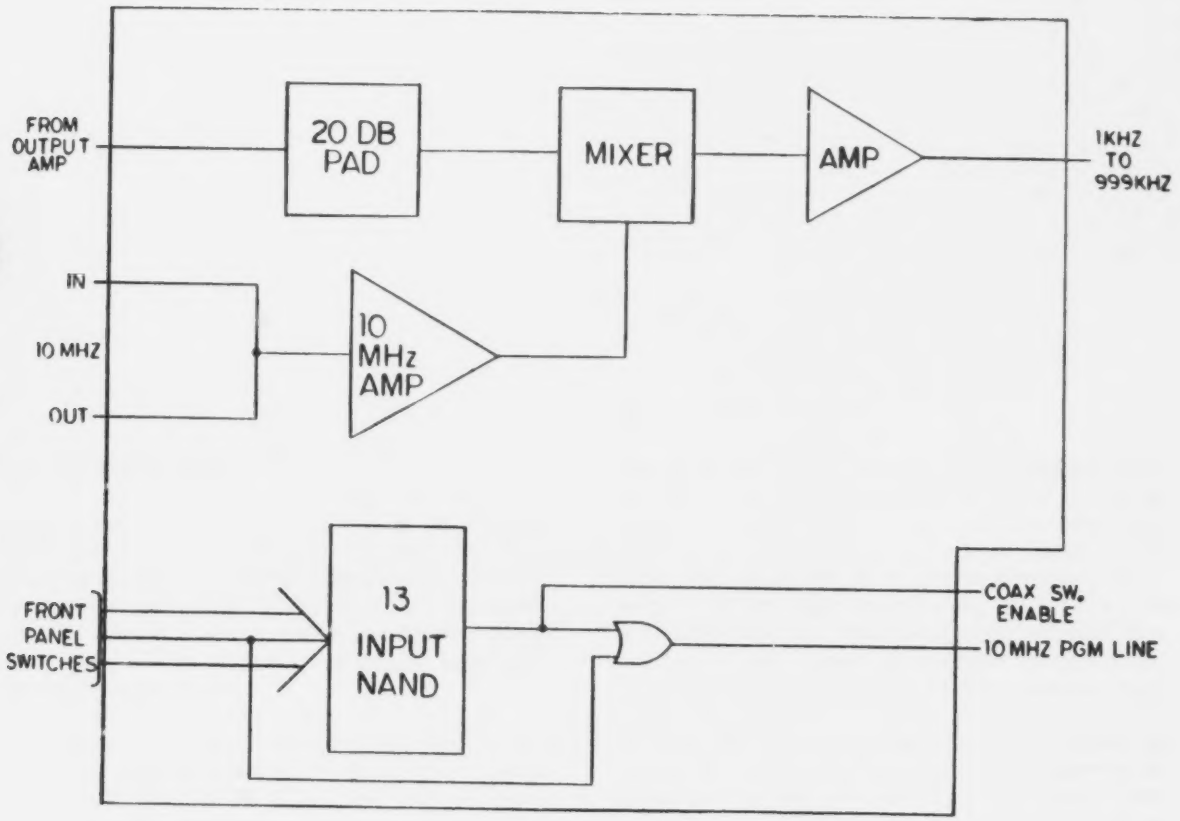


Figure 3-23. M115 Down Converter

SECTION 4

PERFORMANCE TESTS

4.1 INTRODUCTION

The purpose of the performance tests in the following sections is to verify that the SG-1170/U Signal Generator meets its published specifications (Section 1.2). Individual performance tests consist of: the specification to be verified, the method of testing, a list of equipment required, and a detailed test procedure including, in some cases, a simplified setup drawing.

For a list of recommended test equipment, refer to Table 4-1. Except as detailed settings of test equipment apply to performance test procedures, all other test equipment operating details are omitted.

The instrument should have its top and bottom covers installed for the performance tests. All of the tests can be performed without access to the internal controls except for 4.19, RF Protection. Before applying power to the instrument, see Section 2 for details of electrical installation. The line voltage should be maintained as specified throughout the tests. The performance test procedures are begun after a two-hour minimum warmup of the instrument in a +20 to +30° C ambient temperature range.

A copy of the Performance Test Record (PTR) is provided at the end of this section for convenience in recording the performance of the instrument during performance tests. It can be filled out and used as a permanent record for incoming inspection, or it can be used as a guide for routine performance testing. The PTR lists the section, test, and specification limits. All tests refer to this record.

TABLE 4-1. RECOMMENDED TEST EQUIPMENT

EQUIPMENT NO.	NAME OR NOMENCLATURE	NSN
(1)	Digital Multimeter AN/USM-451	6625-00-168-0585
(2)	Distortion Analyzer AN/URM-184	6625-00-871-8012
(3)	Frequency Counter AN/USM-459	6625-01-061-8928
(4)	Function Generator AN/USM-256	6625-00-087-4499
(5)	Power Meter ME-441/U	6625-00-436-4883
(6)	Modulation Meter ME-57A/U	6625-00-647-3737
(7)	Oscilloscope AN/USM-281C	6625-00-106-9622
(8)	Spectrum Analyzer IP-1216(P)/GR	4920-00-424-4370
(9)	Attenuator Pads 10, 20, 30, 40 dB CN-608	6625-00-623-5895
(10)	Wide Band Amplifier AM-3495/U	6625-00-985-8891
(11)	Signal Generator SG-1170/U	6625-01-120-3501
(12)	VSWR Bridge AN/URM-120A/U	6625-01-039-1488
(13)	Coaxial Short HP 11511A	5935-00-937-6255
(14)	Coaxial Terminator HP 908A	5905-00-581-4285
(15)	50 Ohm Load HP 11593A	5905-00-890-3393
(16)	Loop Probe (See Fig. 4-6)	No NSN

4.2 FREQUENCY RANGE AND RESOLUTION TEST

SPECIFICATION

0.001 to 520 MHz selectable in 1 kHz steps with 1 kHz resolution.
1 MHz to 520 MHz selectable in 1 kHz steps with 1 kHz resolution.

METHOD

A frequency counter is used to measure the frequency range and the frequency resolution. Each digit of the Lever/Indicator switches (a total of 56) will be tested.

EQUIPMENT

(3)

PROCEDURE

1. Set the instrument controls as follows:

FREQ VERNIER	CAL
Frequency selector	050.000
MODULATION MODE	CW
MODULATION FREQ	N/A
MODULATION FM/AM	N/A
OUTPUT VERNIER	Full cw
OUTPUT Step Attenuator	+10 dBm

2. Connect the front-panel RF OUT connector to the 50 ohm input of the frequency counter. Set the counter resolution to 100 Hz.

3. Observe the frequency counter reading. Increase the output frequency setting in 1 kHz steps and verify that the frequency counter reading increases by 1.00 kHz ±1 count for each step increase from 1 through 9 kHz. The foregoing procedure verifies the 1 kHz resolution specification.

4. Repeat the procedure in step 3 for all other step increases indicated in the table below, beginning with the 10 kHz digits. If the actual counter frequency increase per step is equal to the allowable increase per step ±1 count for each of the steps indicated in the table, place a check mark in the applicable space on line 1 of the PTR.

LEVER/INDICATOR SWITCH SETTINGS	COUNTER RESOLUTION	INCREASE/STEP (±1 COUNT)
050.000-050.009	100 Hz	1.00 kHz
050.000-050.090	100 Hz	10.000 kHz
050.000-050.900	1 kHz	100.0 kHz
050.000-059.000	1 kHz	1.000 MHz
100.000-190.000	1 kHz	10.000 MHz
020.000-520.000	1 kHz	100.000 MHz

5. Set the Lever/Indicator switches to 0.001 and verify the low end of the frequency range.

4.3 FREQUENCY ACCURACY TEST

SPECIFICATION

All modes (CW, AM and FM) ±0.001% after 15 minutes.
(±0.001% +10 kHz when FREQUENCY VERNIER is not in CAL.)
(FREQUENCY VERNIER range is ±5 kHz.)

METHOD

A frequency counter is used to measure frequency accuracy. With the FREQ VERNIER in CAL, all carrier frequencies are derived from a single

crystal-controlled oscillator. The instrument will be tested at one CW frequency to verify that the crystal-controlled oscillator operates within specified limits.

When the FREQ VERNIER is not in CAL, the carrier frequencies are derived from a voltage-controlled oscillator in addition to the crystal-controlled oscillator. Frequency accuracy with the FREQ VERNIER not in CAL will be measured by utilizing DC modulation equal to maximum peak sinusoidal modulation in both FM modes. The FREQ VERNIER range will be tested in CW mode.

EQUIPMENT

(3)

PROCEDURE

1. Set the instrument controls as follows:

FREQ VERNIER	CAL
Frequency selector	040.000 MHz
MODULATION MODE	CW
MODULATION FREQ	N/A
MODULATION FM/AM	N/A
OUTPUT VERNIER	Full cw
OUTPUT Step Attenuator	+10 dBm

2. Connect the 50 ohm input of the frequency counter to the RF OUT connector.

3. The counter should read between 39,999.60 and 40,000.40 kHz. Record the counter reading to seven places on line 2 of the PTR.

4. Set the instrument controls as follows:

FREQ VERNIER	0 kHz
Frequency selector	001.000 MHz
MODULATION MODE	FMx1
MODULATION FREQ	DC
MODULATION FM/AM	10 kHz

5. The frequency counter should read between 999.99 and 1,020.01 kHz. Record the counter reading to six places on line 3 of the PTR.

6. Set the MODULATION MODE to FMx10.

7. The frequency counter should read between 1,089.99 and 1,110.01 kHz. Record the counter reading to six places on line 4 of the PTR.

8. Set the frequency selector to 002.000 MHz.

9. Set the FREQ VERNIER to +3 kHz, and make a note of the counter reading in Hz.

10. Set the FREQ VERNIER to 0 kHz, and subtract the frequency counter reading in Hz from the reading in step 9. The difference should be between 2500 and 3500 Hz. Record the difference on line 5 of the PTR.

11. Set the FREQ VERNIER to -3 kHz, and subtract the frequency counter reading in Hz from the reading at 0 kHz in step 10. The difference should be as in step 10. Record the difference in Hz on line 6 of the PTR.

4.4 FREQUENCY STABILITY TEST

SPECIFICATION

All modes (CW, AM and FM) < 0.2 ppm/hour
(500 Hz per 10 min when FREQ VERNIER is not in CAL.)

METHOD

The frequency stability is measured with a frequency counter at the indicated time intervals after a 2-hour-minimum warm-up.

EQUIPMENT

(3)

PROCEDURE

1. Set the instrument controls as follows:

FREQ VERNIER	CAL
Frequency selector	520.000 MHz
MODULATION MODE	CW
MODULATION FREQ	N/A
MODULATION FM/AM	N/A
OUTPUT VERNIER	Full cw
OUTPUT Step Attenuator	+10 dBm

2. Connect the 50 ohm input of the frequency counter to the RF OUT connector.

3. Allow the instrument to warm up for two hours minimum. Record the frequency counter readings to nine places at 15-minute intervals for a one-hour period. The difference between the maximum and minimum readings in the one-hour period should not exceed 104 Hz. Record the difference between the maximum and minimum readings in Hz on line 7 of the PTR.

4. Set the FREQ VERNIER to 0 kHz, the MODULATION MODE to FMx1, the MODULATION FREQ to DC, and the MODULATION FM/AM slider to 10 kHz.

5. After a one-minute interval, record the frequency counter readings to nine places at five-minute intervals for a ten-minute period. The difference between the maximum and minimum readings in the ten-minute period should not exceed 500 Hz. Record the difference between the maximum and minimum frequency readings in Hz on line 8 of the PTR.

4.5 OUTPUT LEVEL ACCURACY TESTS

SPECIFICATION

Power Level: +13 to -137 dBm (1 VRMS to 0.03 μVRMS)

Attenuator Range: Continuously adjustable in 10 dB steps and an 11 dB VERNIER. Output level is indicated on a front-panel METER calibrated in dBm and volts RMS.

Level Accuracy Breakdown: Flatness: ±0.75 dB (+13 to -7 dBm); Output METER: ±0.5 dB; Step Attenuator: ±0.2 dB/10 dB step (±0.2 dB calibration error).

METHOD

The level accuracy between +13 and -7 dBm consists of the sum of the output METER error (±0.5 dB) and the flatness (±0.75 dB). Both errors are measured with a power meter.

The output METER error is measured at 50 MHz in two 10 dB output ranges (+13 to +3 dBm and +3 to -7 dBm).

The flatness is measured relative to 50 MHz in 10 MHz steps between 10 and 520 MHz at +12, +3, and -7 dBm output levels.

The level accuracy below -7 dBm depends upon the OUTPUT Step Attenuator error in addition to the output METER error and the flatness.

The OUTPUT Step Attenuator is a combination of pi-pad sections of 10, 20, 30, 30, and 40 dB. These five pi-pads are programmed by cams to provide 0 to 130 dB of attenuation in 10 dB steps as shown in the table below.

OUTPUT STEP ATTENUATOR POSITION	ACTIVE STEP ATTENUATOR PADS (X)				
dBm	10 dB	20 dB	30 dB	30 dB	40 dB
+ 10					
0					
- 10	x				
- 20		x			
- 30			x		
- 40	x		x		
- 50		x	x		
- 60			x	x	
- 70	x		x	x	
- 80		x	x	x	
- 90		x		x	x
-100			x	x	x
-110	x		x	x	x
-120		x	x	x	x
-130	x	x	x	x	x

Note that no Step Attenuator pads are active in the +10 dBm and 0 dBm positions. A leveled PIN diode attenuator reduces the output level by 10 dB in all positions of the OUTPUT Step Attenuator below +10 dBm. The output level over the entire range of +13 dBm to -137 dBm including an 11 dB VERNIER is controlled by the PIN leveler system.

The OUTPUT Step Attenuator error is measured by an RF substitution method. Each of the five pads in the OUTPUT Step Attenuator is measured at 520 MHz. The second 30 dB pad and the 40 dB pad are measured in combination with other pads. A reference output level is set with a power meter. A reference trace is obtained with a spectrum analyzer and a standard attenuator pad. The standard pad is removed and the OUTPUT Step Attenuator position to be measured is substituted. The spectrum analyzer trace is returned to the reference level by resetting the output level. The resulting instrument output level is measured and compared to the original power meter reference level. A 26 dB RF amplifier is required to boost signal levels below the -60 dBm level.

4.5.1 OUTPUT METER ACCURACY TEST

EQUIPMENT

(5)

PROCEDURE

1. Set the instrument controls as follows:

FREQ VERNIER	CAL
Frequency selector	050.000
MODULATION MODE	CW
MODULATION FREQ	N/A
MODULATION FM/AM	N/A
OUTPUT VERNIER	Full cw
OUTPUT Step Attenuator	+10 dBm

2. Calibrate the power meter and power sensor. Set the power meter to the +15 dBm range. Connect the power sensor to the front-panel RF OUT connector. (When reading the power meter, set the range switch so that the meter indicates between 0 and -5 dBm).

NOTE: The indicated output level of the instrument is equal to the sum of the output METER reading and the Step Attenuator setting. The difference between the actual power meter reading and the indicated output level is the output METER error. For example, the indicated output level is +13 dBm for an output METER reading of +3 dBm and an OUTPUT Step Attenuator setting of +10 dBm. If the power meter reading is +13.15 dBm, the output METER error is +0.15 dB.

3. Adjust the front-panel OUTPUT VERNIER for a +3 dBm output METER reading. Observe the power meter reading and make a note of the output METER error to the nearest 0.05 dB (¼ division). Continue to adjust the OUTPUT VERNIER for output METER reading increments of 1 dB between +3 and -7 dBm, and note the output METER error at each reading. As the test progresses, make a note of the maximum output METER error to the nearest 0.05 dB. The allowable error is ±0.5 dB. Record the maximum output METER error on line 9 of the PTR.

4. Set the instrument OUTPUT Step Attenuator to 0 dBm and repeat step 3 above. Record the maximum output METER error on line 10 of the PTR.

4.5.2 FLATNESS TEST

EQUIPMENT

(5)

PROCEDURE

1. Set the instrument controls as in Section 4.5.1.

2. Set the power meter to the +15 dBm range. Connect the power sensor to the front-panel RF OUT connector.

3. Adjust the front-panel OUTPUT VERNIER for a +12 dBm power meter reading.

4. Set the instrument frequency selector in 10 MHz steps between 10 and 520 MHz and observe the maximum change in the power meter readings from the +12 dBm reading in step 3. The maximum allowable change is ±0.75 dB. Record the maximum change to the nearest 0.05 dB (¼ division) on line 11 of the PTR.

5. Set the Lever/Indicator switches to 050.000 MHz and adjust the OUTPUT VERNIER for a +3 dBm power meter reading.

6. Repeat step 4 above except observe the maximum change in the power meter readings from the +3 dBm reading in step 5. Record the maximum change from the +3 dBm reading to the nearest 0.05 dB on line 12 of the PTR.

7. Set the Lever/Indicator switches to 050.000 MHz and the OUTPUT Step Attenuator to 0 dBm. Adjust the OUTPUT VERNIER for a -7 dBm power meter reading.

8. Repeat step 4 above except observe the maximum change in the power meter readings from the -7 dBm reading in step 7. Record the maximum change from the -7 dBm reading to the nearest 0.05 dB on line 13 of the PTR.

4.5.3 STEP ATTENUATOR ACCURACY TEST

EQUIPMENT

(5) (8) (9) (10)

PROCEDURE

1. Set the instrument controls as follows:

FREQ VERNIER	CAL
Frequency selector	520.000
MODULATION MODE	AM
MODULATION FREQ	DC
MODULATION FM/AM	0% AM
OUTPUT VERNIER	Full cw
OUTPUT Step Attenuator	0 dBm

2. Set the power meter to the +5 dBm range. Connect the power sensor to the RF OUT connector.

3. Adjust the OUTPUT VERNIER control for a +1 dBm power meter reading.

4. Disconnect the power sensor from the front-panel RF OUT connector. Connect a standard 10 dB attenuator pad to the RF OUT connector. Connect the output of the attenuator pad to the spectrum analyzer as shown in Figure 4-1.

5. Set the spectrum analyzer to 520 MHz. Use the bandwidth and frequency span controls to obtain a ~ horizontal line on the analyzer display. Set the vertical display to 1 dB/division.

6. Use the log reference controls to obtain a peak trace one division below the log reference line of the spectrum analyzer display. Center the trace in the display with fine tuning.

7. Set the OUTPUT Step Attenuator to -10 dBm.

8. Disconnect the 10 dB attenuator pad from the setup and reconnect the spectrum analyzer to the RF OUT connector.

9. Adjust the MODULATION FM/AM slider to realign the peak of the trace one division below the log reference line as in step 6.

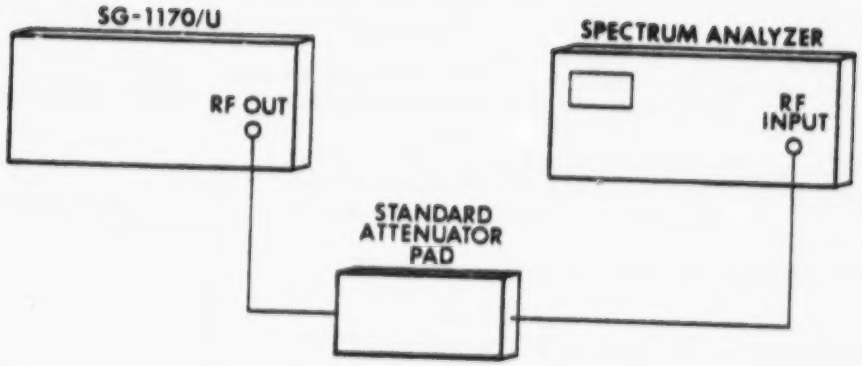


Figure 4-1. Set-up for Step Attenuator Tests

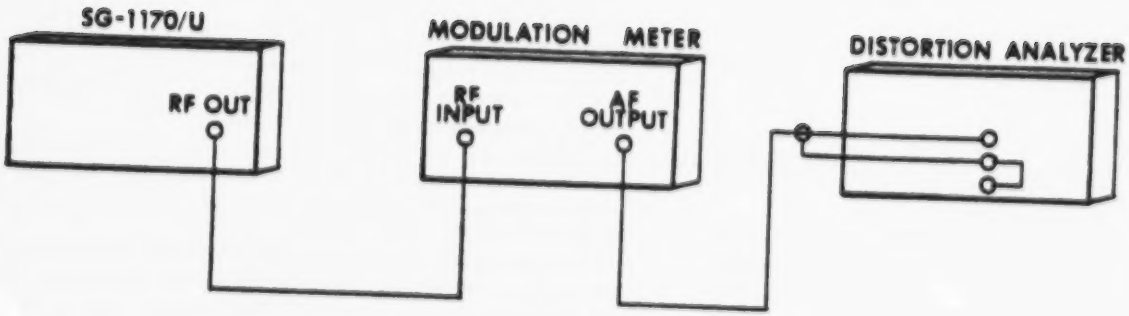


Figure 4-2. Set-up for Distortion Tests

10. Disconnect the cable from the front-panel RF OUT connector. Connect the power sensor and set the OUTPUT Step Attenuator to 0 dBm.

11. Observe the difference between the actual power meter reading and the +1 dBm reference setting in step 3. The difference or error should be ±0.2 dB maximum. Record the error on line 14 of the PTR.

12. Repeat steps 3 through 11 using the standard attenuator pads and the instrument OUTPUT Step Attenuator settings indicated in the following table.

Steps 4 and 8 Attenuator pad (dB)	Step 7 OUTPUT Step Attenuator setting (dBm)	Step 11 Record Error on Line of PTR
20	-20	15
30	-30	16
60	-60	17
90	-90	18

NOTE: To test the OUTPUT Step Attenuator below -20 dBm, an RF amplifier (> 20 dB gain) is required. Insert the amplifier between the standard attenuator pad and the spectrum analyzer (Figure 4-1). The allowable error for the -90 dBm setting (step 11) is ±1.5 dB. The OUTPUT Step Attenuator can be tested down to the -130 dBm position if a 40 dB RF amplifier is used and if precautions are taken to properly shield the RF output from the instrument proper.

4.6 HARMONICS TEST

SPECIFICATION

< -30 dBc from 0.001 to 1 MHz and 10 to 520 MHz
< -26 dBc from 1 to 10 MHz

METHOD

A spectrum analyzer is used to measure harmonics in the frequency range of the instrument at +13 and +3 dBm output levels.

EQUIPMENT

(8)

PROCEDURE

1. Set the instrument controls as follows:

FREQ VERNIER	CAL
Frequency selector	001.000 MHz
MODULATION MODE	CW
MODULATION FREQ	N/A
MODULATION FM/AM	N/A
OUTPUT VERNIER	Full cw
OUTPUT Step Attenuator	+10 dBm

2. Connect the instrument RF OUT connector to the RF input of the spectrum analyzer.

3. Set the spectrum analyzer to measure harmonic distortion for fundamental frequencies between 1 and 10 MHz. Set the bandwidth to 100 kHz, the frequency span per division to 5 MHz, and the display to 10 dB/div. Locate the zero reference at the left edge of the graticule, and adjust the fundamental amplitude to the log reference line (0 dB) in the display.

4. Using the analyzer reference level control to maintain a constant fundamental reference level, increase the setting of the frequency selector in 1 MHz steps between 1 and 10 MHz while observing the spectrum analyzer display. The harmonics should be > 26 dB below the fundamental. Record the maximum harmonic observed in the display in dB below the fundamental on line 19 of the PTR.

5. Set the OUTPUT Step Attenuator to 0 dBm and repeat steps 3 and 4 at the +3 dBm output level. Record the maximum harmonic observed in dB below the fundamental on line 20 of the PTR.

6. Repeat steps 1 through 5 for Lever/Indicator switch settings between 000.450 and 000.999, incremented in 10 kHz steps. Note the harmonic levels, but do not record them in the PTR as yet.

7. Set the frequency selector to 10 MHz and the OUTPUT Step Attenuator to +10 dBm.

8. Set the spectrum analyzer to measure harmonic distortion for fundamental frequencies between 10 and 520 MHz. Use the analyzer bandwidth and frequency span controls to obtain optimum trace presentation.

9. Using the analyzer reference level control to maintain a constant fundamental reference level, increase the setting of the frequency selector in 10 MHz steps between 10 and 520 MHz while observing the spectrum analyzer display. The harmonics should be > 30 dB below the fundamental. Record the maximum harmonic observed in the display in dB below the fundamental on line 21 of the PTR.

10. Set the OUTPUT Step Attenuator to 0 dBm and repeat steps 7 and 8 at the +3 dBm output level. Record the maximum harmonic observed in dB below the fundamental on line 22 of the PTR.

4.7 NON-HARMONICS TEST

SPECIFICATION

Fundamental Range (MHz)	Non-harmonic Range (MHz)	Non-harmonic level (dBc)
below 3	below 3	< -60
3 to 250	3 to 250	< -65
3 to 350	3 to 350	< -55
3 to 520	3 to 1000	< -35

METHOD

A spectrum analyzer is used to measure the level of non-harmonics at the maximum specified output level of +13 dBm.

EQUIPMENT

(8)

PROCEDURE

1. Set the instrument controls as follows:

FREQ VERNIER	CAL
Frequency selector	000.001 MHz
MODULATION MODE	CW
MODULATION FREQ	N/A
MODULATION FM/AM	N/A
OUTPUT VERNIER	Full cw
OUTPUT Step Attenuator	+10 dBm

2. Connect the RF OUT connector to the RF input of the spectrum analyzer.

3. Set the spectrum analyzer to measure the non-harmonic content of the output below 3 MHz. Set the bandwidth to 30 kHz, the frequency span per division to 1 MHz, and the display to 10 dB/div. Locate the zero reference at the left edge of the graticule, and adjust the fundamental to the log reference line (0 dB) in the display.

4. Increase the setting of the frequency selector in 1 MHz steps up to 3 MHz. The non-harmonics below 3 MHz should be at least 60 dB below the fundamental (<-60 dBc). Record the maximum non-harmonic observed in the display in dB below the fundamental on line 23 of the PTR.

5. Set the spectrum analyzer to measure the non-harmonic content of the output between 3 and 250 MHz. Use the analyzer bandwidth and frequency span controls to obtain optimum trace presentation.

6. Increase the setting of the frequency selector in 1 MHz steps between 3 and 10 MHz and in 10 MHz steps between 10 and 520 MHz while observing the spectrum analyzer display. Use the table below to determine the maximum non-harmonic level in each of the frequency ranges shown. Record the maximum non-harmonic level observed in each range indicated in the table on the applicable line of the PTR.

FUNDAMENTAL RANGE (MHz)	NON-HARMONIC RANGE (MHz)	NON-HARMONIC LEVEL (dBc)	PTR LINE NUMBER
3-250	3-250	<-65	24
3-350	3-350	<-55	25
3-520	3-1000	<-35	26

4.8 RESIDUAL AM TEST

SPECIFICATION

<-65 dBc in a 50 Hz to 15 kHz post-detection bandwidth.

METHOD

A modulation meter operating in AM mode is used to demodulate the output at the minimum leveler point where AM noise is maximum. A distortion analyzer (operating in level mode) is used to increase the resolution of the demodulated output of the modulation meter. The system is referenced at a 10% AM level. The 10% AM is removed and the residual AM is read in dB below the 10% AM level reference. 20 dB is added to the reading to relate residual AM to the carrier.

EQUIPMENT

(2) (6)

PROCEDURE

1. Set the instrument controls as follows:

FREQ VERNIER	CAL
Frequency selector	500.000 MHz
MODULATION MODE	AM
MODULATION FREQ	1 kHz
MODULATION FM/AM	0% AM
OUTPUT VERNIER	-7 dB
OUTPUT Step Attenuator	0 dBm

2. Connect the equipment as shown in Figure 4-2.

3. Set the modulation meter to read %AM at 500 MHz. Set the RF input attenuation to 10 dB, the IF bandwidth to ±400 kHz, the meter response to fast, the function switch to +AM, the meter range switch to 10, and the filter bandwidth to 50 Hz – 15 kHz.

4. Adjust the MODULATION FM/AM control for a modulation meter reading of 10% AM. NOTE: 10% AM is obtained at a full-scale reading of 100 with the modulation meter range switch set to 10.

5. With the distortion analyzer operating in level mode, reference it for a 0 dB meter reading. The system is now referenced at a level 20 dB below the carrier. Since the modulating signal and carrier amplitudes are equal at 100% AM, it follows that at 10% AM the modulating signal is 20 dB below the carrier.

6. Set the MODULATION MODE to CW.

7. Without disturbing the instrument and modulation meter controls, set the distortion analyzer to read residual AM. Set the range switch so that the meter reads between 0 and -10 dB. First, read the residual AM below the 0 dB reference level in step 5. Then add 20 dB to the above reading to obtain the residual AM below the carrier. (For example, a 48 dB residual AM below the 0 dB reference +20 dB = 68 dB residual AM below the carrier, or -68 dBc.) The residual AM should be <-65 dBc. Record the residual AM in dBc on line 27 of the PTR.

As many other carrier frequencies may be tested as desired.

4.9 RESIDUAL FM TEST

SPECIFICATION

<200 Hz in a 50 Hz to 15 kHz post-detection bandwidth.
<100 Hz in a 300 Hz to 3 kHz post-detection bandwidth.

METHOD

A modulation meter which is set to read frequency deviation is used to measure residual FM. The test is performed at maximum frequency and output level. The instrument is operated in an FM mode where the residual FM is greatest.

The residual FM is measured in an environment where the noise level <60 dB relative to 2×10^{-4} μbar.

EQUIPMENT

(6)

PROCEDURE

1. Set the instrument controls as follows:

FREQ VERNIER	CAL
Frequency selector	520.000 MHz
MODULATION MODE	FMx10
MODULATION FREQ	EXT
MODULATION FM/AM	0 kHz
OUTPUT VERNIER	Full cw
OUTPUT Step Attenuator	+10 dBm

2. Connect the RF OUT connector to the 50 ohm RF input of the modulation meter.

3. Set the modulation meter to read FM deviation at 520 MHz. Set the

meter range switch to 3, the RF input attenuation to 20 dB, the IF bandwidth to ±400 kHz, the meter response to fast, and the filter bandwidth to 50 Hz – 15 kHz.

4. Measure the average level of the FM deviation on the modulation meter (disregard occasional peaks). The residual FM should be <200 Hz. Read the residual FM with the function switch set to +FM and -FM. Record the greater of the two readings in Hz on line 28 of the PTR.

As many other frequencies may be tested as desired.

4.10 INTERNAL MODULATION FREQUENCY TEST

SPECIFICATION

400 Hz and 1 kHz ±5%

METHOD

A frequency counter is used to measure modulation frequency at the instrument rear-panel MOD TP. Since the internal 400 Hz and 1 kHz oscillators are used for both the AM and FM modes, this test will suffice for both modes.

EQUIPMENT

(3)

PROCEDURE

1. Set the instrument controls as follows:

FREQ VERNIER	N/A
Frequency selector	N/A
MODULATION MODE	N/A
MODULATION FREQ	400 Hz
MODULATION FM/AM	Mid-range
OUTPUT VERNIER	N/A
OUTPUT Step Attenuator	N/A

2. Connect the low frequency input of the frequency counter to the MOD TP (pin 36 of rear-panel PROGRAMMING jack J101) and the cable shield to ground (pin 25 of J101). (See Figure 2-3 and Schematic 1).

3. The counter should read between 380 and 420 Hz. Record the counter reading on line 29 of the PTR.

4. Set the MODULATION FREQ control to 1 kHz.

5. The counter should read between 950 and 1050 Hz. Record the counter reading on line 30 of the PTR.

4.11 PERCENT AM ACCURACY TEST

SPECIFICATION

±(5% + 5% of reading) at a frequency of 1 kHz. NOTE: This specification applies for output limits ≤+3 dBm. AM is possible above +3 dBm if the peak of the modulated output does not exceed +13 dBm.

METHOD

The %AM accuracy is measured with a modulation meter after the front-panel MODULATION FM/AM control error, which is ±4%, is subtracted out. The MODULATION FM/AM slider accuracy, which consists of the control linearity and the modulation scale errors, is measured in terms of the DC voltage at the rear-panel MOD TP. The calibration of the voltage across the control at maximum position is checked initially.

The remaining %AM accuracy, which is ±(5% of the reading + 1% of full scale), is measured by the modulation meter with accurately measured voltage applied to the modulation system. The measurement uncertainty is 2% of the reading + 1% of full scale.

EQUIPMENT

(1) (6)

PROCEDURE

1. Set the instrument controls as follows:

FREQ VERNIER	CAL
Frequency selector	520.000 MHz
MODULATION MODE	CW
MODULATION FREQ	DC
MODULATION FM/AM	0% AM
OUTPUT VERNIER	-3 dB
OUTPUT Step Attenuator	0 dBm

2. Connect the equipment as shown in Figure 4-3. Connect the center conductor of the cable between the high terminal of the digital multimeter and the MOD TP (pin 36 of rear-panel PROGRAMMING jack J101). Connect the cable shield between the low terminal of the digital multimeter and ground (pin 25 of J101).

3. Set the MODULATION FM/AM slider to its full up position.

4. The digital multimeter should read 5.000 ±0.020 VDC. If the voltage is within limits, continue to step 5. If not, recalibrate (Section 5.3.9).

5. Set the MODULATION FM/AM slider to 30% AM.

6. The digital multimeter should read between 1.300 and 1.700 VDC. Record the reading on line 31 of the PTR.

7. Set the MODULATION FM/AM slider to 90% AM.

8. The digital multimeter should read between 4.300 and 4.700 VDC. Record the reading on line 32 of the PTR. NOTE: This concludes the MODULATION FM/AM control accuracy test. As many other points may be tested as desired.

9. Adjust the MODULATION FM/AM slider to 0% AM.

10. Set the modulation meter to read %AM at 520 MHz. Set the meter range switch to 100, the RF input attenuation to 10 dB, the IF bandwidth to ±400 Hz, the meter response to fast, the function switch to +AM, and the filter bandwidth to 50 Hz – 15 kHz.

11. Adjust the MODULATION FM/AM slider for a reading of 1.500 ±0.003 VDC on the digital multimeter. Set the MODULATION FREQ switch to 1 kHz and the MODULATION MODE switch to AM.

12. Make a note of the modulation meter reading in %AM. Set the modulation meter function switch to -AM, and note the modulation meter %AM reading as before. Compute the average of the two readings. The average %AM should be between 27.5 and 32.5%. Record the average %AM to the nearest 0.5% on line 33 of the PTR.

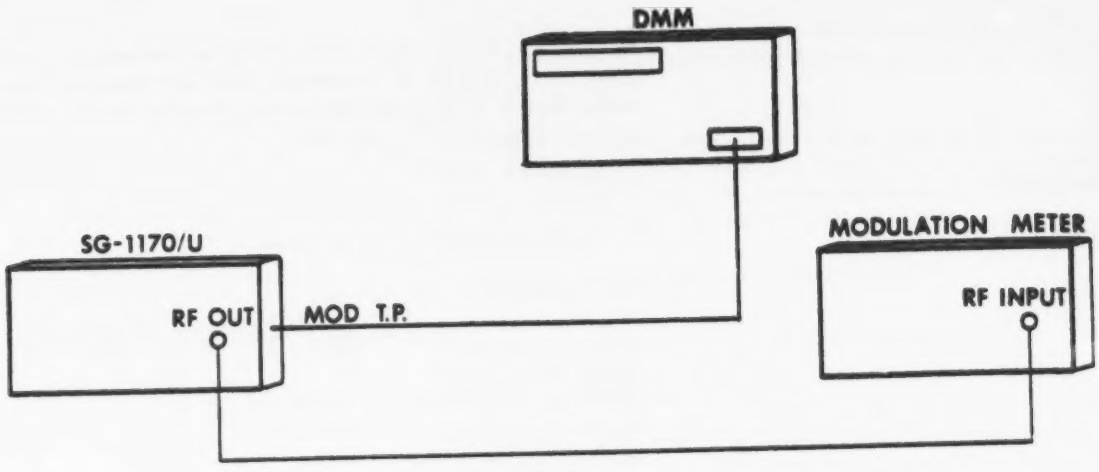


Figure 4-3. Set-up for Percent AM Accuracy Test

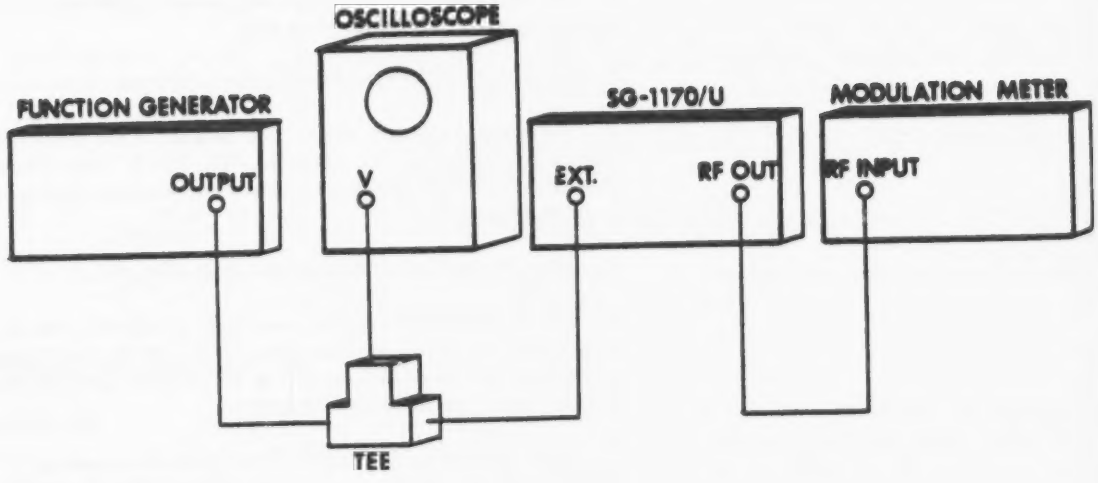


Figure 4-4. Set-up for AM Bandwidth Test

13. Set the MODULATION MODE switch to CW and the MODULATION FREQ switch to DC.

14. Adjust the MODULATION FM/AM control for a reading of 4.500 ±0.003 VDC on the digital multimeter. Set the MODULATION FREQ switch to 1 kHz and the MODULATION MODE switch to AM.

15. Make a note of the modulation meter reading in %AM. Set the modulation function switch to +AM and note the modulation meter %AM reading as before. Compute the average of the two readings. The average %AM should be between 84.5 and 95.5% AM. Record the average %AM to the nearest 0.5% on line 34 of the PTR.

As many other points may be tested as desired.

4.12 AM BANDWIDTH TEST

SPECIFICATION

DC to 20 kHz (3 dB bandwidth), input level required = 5 Vpp into 600 ohms to provide calibrated %AM control.

METHOD

The measurement is made with a modulation meter operating in AM mode and a function generator. The function generator supplies an external sine wave to amplitude modulate the instrument. The system is calibrated at -6 dB on the modulation meter dB scale (approximately 50% AM). The external modulation frequency is increased from 1 kHz to 20 kHz and the AM bandwidth is measured as the change in dB from the calibration level.

EQUIPMENT

(4) (6) (7)

PROCEDURE

1. Set the instrument controls as follows:

FREQ VERNIER	CAL
Frequency selector	050.000 MHz
MODULATION MODE	AM
MODULATION FREQ	EXT
MODULATION FM/AM	0% AM
OUTPUT VERNIER	+3 dB
OUTPUT Step Attenuator	0 dBm

2. Connect the equipment as shown in Figure 4-4.

3. Set the modulation meter to read %AM at 50 MHz. Set the RF input attenuation to 20 dB, the IF bandwidth to ±400 kHz, the meter response to fast, the function switch to +AM, the meter range switch to 100, and the filter bandwidth to 75 kHz.

4. Set the function generator for a 1 kHz sine wave output and the attenuator controls for a 5 Vpp sine wave on the oscilloscope.

5. Adjust the FM/AM control for a modulation meter reading of -6 dB (approximately 50% AM).

6. Maintain the 5 Vpp output level and increase the function generator frequency from 1 to 20 kHz. Observe the modulation meter scale. It should read between -6 and -9 dB. Note the change in dB from the -6 dB calibration level.

7. Repeat steps 4 through 6 with the modulation meter function switch set to -AM. Note the change in dB from the -6 dB setting as in step 6.

8. Record the larger of the two changes obtained in steps 6 and 7 on line 35 of the PTR.

4.13 AM DISTORTION TEST

SPECIFICATION

2% distortion to 30% AM; 3% distortion to 70% AM; 5% distortion to 90% AM at a frequency of 1 kHz. Note: This specification applies for output limits ≤+3 dBm. AM is possible above +3 dBm if the peak of the modulated output does not exceed +13 dBm.

METHOD

The measurement is made with a modulation meter and a distortion analyzer which measures the distortion of the demodulated AM from the modulation meter. The measurement is made at the minimum leveler point where the AM distortion is normally worst-case.

EQUIPMENT

(2) (6)

PROCEDURE

1. Set the instrument controls as follows:

FREQUENCY VERNIER	CAL
Frequency selector	520.000 MHz
MODULATION MODE	AM
MODULATION FREQ	1 kHz
MODULATION FM/AM	0% AM
OUTPUT VERNIER	-7 dB
OUTPUT Step Attenuator	0 dBm

2. Connect the equipment as shown in Figure 4-2.

3. Set the modulation meter to read %AM at 520 MHz. Set the RF input attenuation to 10 dB, the IF bandwidth to ±400 kHz, the meter response to fast, the function switch to +AM, the meter range switch to 30, and the filter bandwidth to 50 Hz to 15 kHz.

4. Adjust the MODULATION FM/AM slider for a modulation meter reading of 30% AM. Set the modulation meter function switch to -AM, and observe the modulation meter reading. Readjust the MODULATION FM/AM slider until the average of the two modulation meter readings in +AM and -AM positions of the modulation meter function switch is equal to 30% AM.

5. Calibrate the distortion analyzer and measure the distortion. The distortion should be less than 2%. Record the distortion on line 36a of the PTR.

6. Set the meter range switch to 100.

7. Adjust the MODULATION FM/AM slider as in step 4 until the average of the modulation meter readings in +AM and -AM positions of the modulation function switch is equal to 70% AM.

8. Calibrate the distortion analyzer and measure the distortion. The distortion should be less than 3%. Record the distortion on line 36b of the PTR.

9. Adjust the MODULATION FM/AM slider as in step 4 until the average of the modulation meter readings in +AM and -AM positions of the modulation function switch is equal to 90% AM.

10. Calibrate the distortion analyzer and measure the distortion. The distortion should be less than 5%. Record the distortion on line 37 of the PTR.

4.14 FM DEVIATION ACCURACY TEST

SPECIFICATION

±500 Hz on FMx1 range; ±5 kHz on FMx10 range.

METHOD

The deviation is measured in both FM modes using an internal DC voltage equal to the peak of the internal sine wave voltages. A frequency counter is used to measure the maximum deviation in both FM modes.

EQUIPMENT

(3)

PROCEDURE

1. Set the instrument controls as follows:

FREQ VERNIER	0 kHz
Frequency selector	050.000 MHz
MODULATION MODE	FMx1
MODULATION FREQ	DC
MODULATION FM/AM	10 kHz on FM scale
OUTPUT VERNIER	Full cw
OUTPUT Step Attenuator	+10 dBm

2. Connect the 50 ohm input of the frequency counter to the RF OUT connector.

3. Read the frequency counter and record the reading to 8 places on line 38 of the PTR.

4. Adjust the MODULATION FM/AM slider to 0 kHz deviation on the FM scale.

5. Read the frequency counter and record the reading to 8 places on line 39 of the PTR.

6. Subtract the reading obtained in step 5 from the reading obtained in step 3. The difference between the two readings should be between 9.500 and 10.500 kHz. Record the difference in kHz on line 40 of the PTR.

7. Set the MODULATION MODE TO FMx10 and adjust the MODULATION FM/AM slider to 10 kHz deviation of the FM scale.

8. Read the frequency counter and record the reading to 6 places on line 41 of the PTR.

9. Adjust the MODULATION FM/AM slider to 0 kHz deviation on the FM scale.

10. Read the frequency counter and record the reading to 6 places on line 42 of the PTR.

11. Subtract the reading obtained in step 10 from the reading obtained in step 8. The difference between the two readings should be between 95.0 and 105.0 kHz. Record the difference in kHz on line 43 of the PTR.

4.15 FM BANDWIDTH TEST

SPECIFICATION

External, 50 Hz to 15 kHz, (1 dB bandwidth), input level required = 10 Vpp into 600 ohms to provide calibrated deviation control.
(DC to 25 kHz when FREQ VERNIER is not in CAL position.)

METHOD

The measurement is made with a modulation meter and a function generator. The function generator supplies an external sine wave to frequency modulate the instrument. The system is calibrated with a 1 kHz external sine wave at an indicated deviation 1 dB below the 0 dB reference on the modulation meter dB scale (approximately 90 kHz deviation). The external modulation frequency is varied from 1 kHz to 50 Hz, and from 1 kHz to 25 kHz, and the FM bandwidth is measured as the change in dB from the calibrated level.

EQUIPMENT

(4) (6) (7)

PROCEDURE

1. Set the instrument controls as follows:

FREQUENCY VERNIER	CAL
Frequency selector	520.000 MHz
MODULATION MODE	FMx10
MODULATION FREQ	EXT
MODULATION FM/AM	0 kHz
OUTPUT VERNIER	+3 dB
OUTPUT Step Attenuator	+10 dBm

2. Connect the equipment as shown in Figure 4-4.

3. Set the modulation meter to read FM deviation at 520 MHz. Set the RF input attenuation to 20 dB, the IF bandwidth to ±400 kHz, the meter response to fast, the function switch to +FM, the meter range switch to 100, and the filter bandwidth to 75 kHz.

4. Set the function generator for a 1 kHz sine wave output and the attenuator controls for a 5 Vpp sine wave on the oscilloscope.

5. Adjust the MODULATION FM/AM slider for a modulation meter reading of -1 dB (approximately 90 kHz deviation).

6. Maintain the 5 Vpp external input level during this step. Slowly decrease the function generator frequency from 1 kHz to 50 Hz, and then slowly increase the frequency to 25 kHz while observing the dB scale on the modulation meter. It should read between 0 and -2 dB. Note the maximum change from the -1 dB reference (step 5) to the nearest 0.25 dB.

7. Repeat steps 4 through 6 with the modulation meter function switch set to -FM. Note the change from -1 dB reference as in step 6. Record the larger of the two changes in dB (in this step and in step 6) on line 44 of the PTR.

4.16 FM DISTORTION TEST

SPECIFICATION

2% (10 kHz to 100 kHz deviation) at a frequency of 1 kHz.
4% (3 kHz to 10 kHz deviation) at a frequency of 1 kHz.

METHOD

The measurement is made with a modulation meter and a distortion analyzer which measures the distortion of the demodulated FM from the modulation meter. Distortion below 3 kHz deviation increases because of residual FM noise. The distortion at 3 kHz deviation is measured in an environment where the noise level <60 dB relative to 2×10^{-4} μbar.

EQUIPMENT

(2) (6)

PROCEDURE

1. Set the instrument controls as follows:

FREQ VERNIER	CAL
Frequency selector	520.000 MHz
MODULATION MODE	FMx1
MODULATION FREQ	1 kHz
MODULATION FM/AM	3 kHz
OUTPUT VERNIER	Full cw
OUTPUT Step Attenuator	+10 dBm

2. Connect the equipment as shown in Figure 4-2.

3. Set the modulation meter to read FM deviation at 520 MHz. Set the RF input attenuation to 20 dB, the IF bandwidth to ±400 kHz, the meter response to fast, the function switch to +FM, the meter range switch to 3, and the filter bandwidth to 50 Hz – 15 kHz. The modulation meter should read approximately 3 kHz.

4. Calibrate the distortion analyzer and measure distortion. The distortion should be less than 4%. Record the distortion on line 45 of the PTR.

5. Set the meter range switch of the modulation meter to 30. Set the MODULATION MODE to FMx10.

6. Adjust the MODULATION FM/AM for a reading of 30 kHz deviation on the modulation meter.

7. Calibrate the distortion analyzer and measure the distortion. The distortion should be less than 2%. Record the distortion on line 46 of the PTR.

4.17 IMPEDANCE TEST

SPECIFICATION

50 ohms, VSWR 1.25 at RF output levels below 0.1 VRMS.

METHOD

The measurement is made with a VSWR bridge and the return loss is displayed on a spectrum analyzer. An RF signal from a signal generator is fed to the input of the bridge. A reference level is established by shorting the bridge output port. The short is replaced by the RF impedance of the instrument. The signal generator is tuned throughout its range and the return loss versus frequency is displayed.

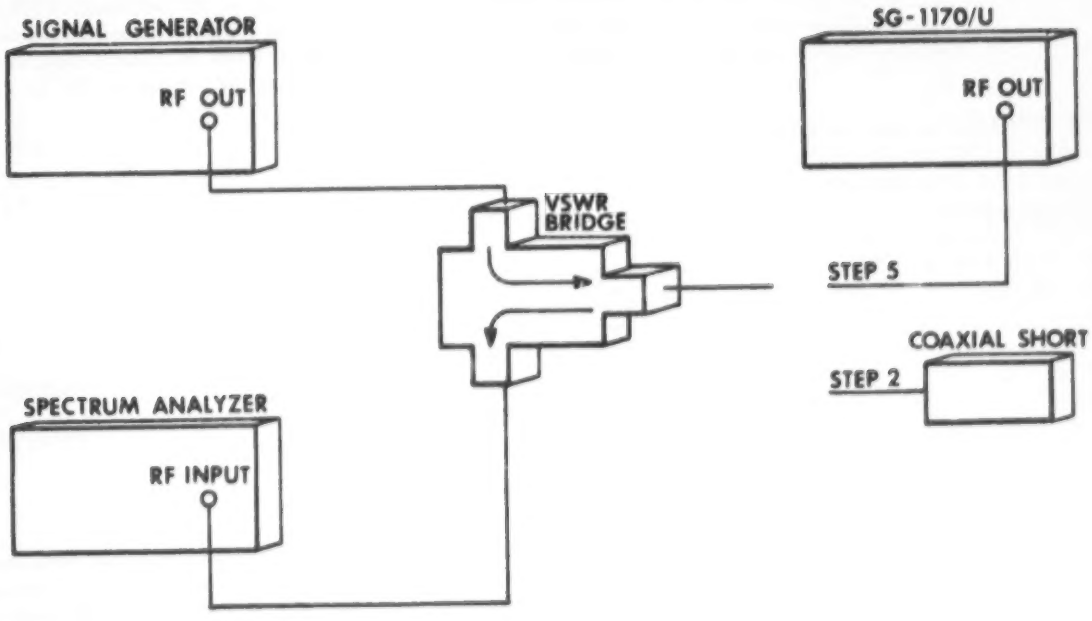


Figure 4-5. Set-up for Impedance Test

EQUIPMENT

(8) (11) (12) (13)

PROCEDURE

1. Set the instrument controls as follows:

FREQ VERNIER	CAL
Frequency selector	520.000 MHz
MODULATION MODE	CW
MODULATION FREQ	N/A
MODULATION FM/AM	N/A
OUTPUT VERNIER	+3 dB
OUTPUT Step Attenuator	-10 dBm

2. Use the setup in Figure 4-5. Connect the signal generator to the input port, the spectrum analyzer to the reflected output port and the coaxial short to the device-under-test port of the VSWR bridge.

3. Set the signal generator output level to -10 dBm, the mode to CW, and the frequency to 250 MHz.

4. Set the spectrum analyzer to span 0 to 500 MHz and the bandwidth to 300 kHz. Use the log reference level controls to calibrate the 250 MHz signal at the top line (0 dB reference) of the display graticule.

5. Disconnect the coaxial short and connect the device-under-test port of the VSWR bridge to the RF OUT connector. Tune the signal generator throughout the instrument's range and verify that the signal level in the display is 19 dB below the 0 dB reference. Disregard the signal at 520 MHz. Record the reading in dB below the reference on line 47 of the PTR.

4.18 RFI TEST

SPECIFICATION

< 1.0 μV is induced in a two-turn, one-inch diameter loop which is held one inch away from any surface. Loop feeds a 50 ohm receiver.

METHOD

A 50 ohm receiver consisting of a 26 dB amplifier and a spectrum analyzer are calibrated at a 1 μV level using the instrument. A loop probe is then connected to the receiver and the leakage is measured at a one-inch distance from the external surfaces of the instrument with the RF OUT connector terminated in 50 ohms. A screen room may be required for this measurement.

EQUIPMENT

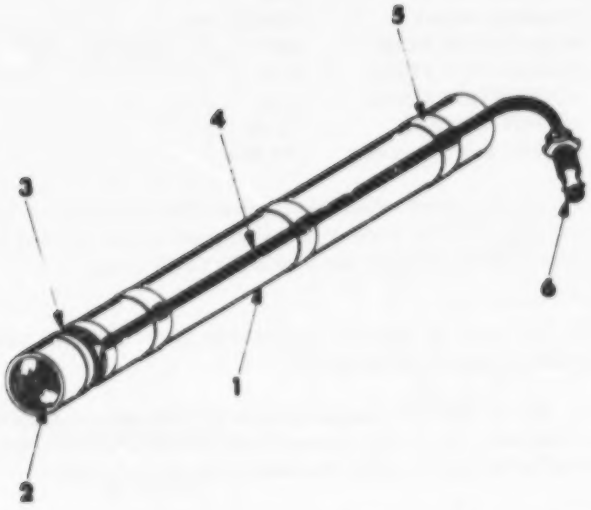
(8) (10) (14) (15) (16)

PROCEDURE

1. Set the instrument controls as follows:

FREQ VERNIER	CAL
Frequency selector	500.000 MHz
MODULATION MODE	CW
MODULATION FREQ	N/A
OUTPUT VERNIER	+3 dB
OUTPUT Step Attenuator	-110 dBm

2. Connect the equipment as shown in Figure 4-7.



1. Rexolite Rod: 1.25 in. dia. by 11 in.
2. Hole: 1.00 in dia. by 0.80 in. deep.
3. Groove: 0.120 in wide by 0.125 in deep 1.00 in from end of rod.
4. Coaxial Cable: (RG-174/U) 0.110" diameter by 19" long. Strip shield for 7 in, and cut off shield to ¼ in length. Strip insulation from center conducter ¼ in. Wind 2 turns of insulated center conductor in groove of rod. Solder shield to center conductor, and insulate the solder joint.
5. Wind mylar tape around the two-turn loop, and around the rod (three places).
6. BNC male connector.

Figure 4-6. Loop Probe

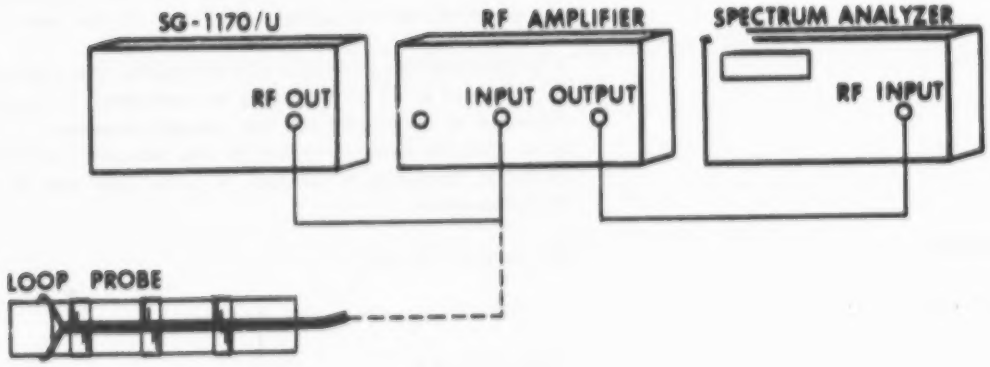


Figure 4-7. Set-up for RFI Test

3. Set the spectrum analyzer bandwidth to 100 kHz, the scan width to 0.5 MHz/division, the video filter to 100 Hz, the input attenuation to 0 dB and the log reference level to -50 dBm with a 10 dB/division vertical scale. Center the signal in the display using the center frequency control. Calibrate the analyzer for the -107 dBm signal at the -31 dBm graticule using the log reference controls.

4. Disconnect the RF amplifier from the instrument and connect the 50 ohm coaxial terminator to the RF OUT connector of the instrument. Tighten the terminator to minimize RF leakage.

5. Set the OUTPUT Step Attenuator to -10 dBm and the OUTPUT VERNIER for a +3 dBm reading on the output METER.

6. Connect the loop probe to the input of the RF amplifier. Move the loop probe over the surfaces of the instrument with the two-turn loop at a one-inch distance. The signal plus noise should be less than the -107 dBm reference (step 2). Record the maximum reading in dBm on line 48 of the PTR.

4.19 RF PROTECTION CHECK

The following procedure is recommended to insure proper operation of the RF Protection Circuit. Remove the top cover from the instrument and locate the M35-2 RF Circuit Breaker module (see fig. 5-6).

With the instrument operating normally in CW mode, set the output level to +5 dBm. Connect a power meter to the RF OUT connector. Set the instrument output frequency to 50 MHz.

The circuitry in the M35-2 is checked by pushing the momentary switch located on top of the module. This switch lowers the trip level of the module. While holding down the switch, slowly increase the instrument output level with the OUTPUT VERNIER until the M35-1 trips. This causes the circuit breaker to open and latch, the UNLEVELED lamp to flash, and the output level to go to zero. The circuit breaker can then be reset by momentarily turning the POWER switch off. The M35-1 should have tripped at +7.5 dBm ±1 dB. Perform the same test at 520 MHz. It should then trip at +10.5 dBm ±2 dB.

The above procedure, while not a complete performance check, is considered adequate for most applications. Additional tests can be performed as desired. For example, insertion loss and VSWR can be checked in the same manner as any passive device. Also, if available, a high power RF signal source, set for an output of slightly greater than .7 W, can be used to verify circuit breaker operation.

If the RF Protection Circuit is operating properly, place a check mark on line 49 of the PTR.

PERFORMANCE TEST RECORD
SG-1170/U

S/N _____
DATE _____

SEC	TEST	MINIMUM SPECIFICATION	MEASUREMENT	MAXIMUM SPECIFICATION	LINE
4.2	FREQ RANGE		( ) CHECK		1
4.3	FREQ ACCURACY	39,999.60 kHz	kHz	40,000.40 kHz	2
		999.99 kHz	Hz	1,020.01 kHz	3
		1,089.99 kHz	Hz	1,110.01 kHz	4
		2500 Hz	Hz	3500 Hz	5
			Hz		6
4.4	FREQ STABILITY		Hz	104 Hz	7
			Hz	500 Hz	8
4.5.1	METER ACCURACY	-0.5 dB	dB	+0.5 dB	9
			dB		10
4.5.2	FLATNESS	-0.75 dB	dB	+0.75 dB	11
			dB		12
			dB		13
4.5.3	STEP ATT ACCURACY	-0.2 dB	dB	+0.2 dB	14
		-0.4 dB	dB	+0.4 dB	15
		-0.6 dB	dB	+0.6 dB	16
		-1.2 dB	dB	+1.2 dB	17
		-1.8 dB	dB	+1.8 dB	18
4.6	HARMONICS	26 dB down	dB		19
			dB		20
		30 dB down	dB		21
			dB		22
4.7	NON-HARMONICS	60 dB down	dB		23
		65 dB down	dB		24
		55 dB down	dB		25
		35 dB down	dB		26
4.8	RESIDUAL AM	65 dB down	dB		27
4.9	RESIDUAL FM		Hz	200 Hz	28
4.10	INT MOD FREQUENCY	380 Hz	Hz	420 Hz	29
		950 Hz	Hz	1050 Hz	30
4.11	FM/AM CONTROL ACC	1.300 VDC	VDC	1.700 VDC	31
		4.300 VDC	VDC	4.700 VDC	32
	AM SYSTEM ACCURACY	27.5 %	%	32.5 %	33
		84.5 %	%	95.5 %	34
4.12	AM BANDWIDTH		dB	3 dB	35
4.13	AM DISTORTION		%	2%	36a
			%	3%	36b
			%	5%	37
4.14	FM DEVIATION ACC		kHz		38
			kHz		39
		9.500 kHz	kHz	10.500 kHz	40
			kHz		41
			kHz		42
		95.0 kHz	kHz	105.0 kHz	43
4.15	FM BANDWIDTH		dB	1 dB	44
4.16	FM DISTORTION		%	4 %	45
			%	2 %	46
4.17	IMPEDANCE	19 dB down	dB		47
4.18	RFI		dBm	-107 dBm	48
4.19	RF PROTECTION		( ) CHECK		49

SECTION 5

MAINTENANCE

5.1 INTRODUCTION

This section provides information for disassembly, alignment, and troubleshooting the SG-1170/U Signal Generator.

Measurements and adjustments will be facilitated by placing the instrument on its right side, as access is required to the top and bottom of the unit for adjustments and test points.

5.2 SERVICE INFORMATION

5.2.1 DISASSEMBLY INFORMATION

Refer to Figure 5-1. The side panels form part of the support for the top and bottom covers; therefore these covers should be removed before removing either side panel. The covers and panels can be removed as indicated below.

NOTE

One side panel must remain on the instrument to secure the front-panel assembly to the chassis.

REMOVAL OF TOP COVER – Remove the single screw (B) and lift the cover off with a slight rear movement. Reinstall the cover by reversing the removal procedure.

REMOVAL OF BOTTOM COVER – Remove the two rear feet (A) and lift the cover off with a slight rear movement. Reinstall the cover by reversing the removal procedure.

REMOVAL OF FRONT-TOP AND FRONT-BOTTOM RAILS – The rails may be removed to facilitate removal of the Meter Board or Modulation Board assembly. Each rail is removed by removing the three screws (D) and lifting the rail off.

REMOVAL OF SIDE PANEL – Either side panel can be removed to provide better access by removing the six screws (E) holding the side panel to the instrument.

CAUTION

To prevent possible damage when reinstalling side panels, use only the original screws or equivalent. Longer screws in the bottom two holes can cause damage to wiring.

5.2.2 MODULE SERVICING

REMOVAL OF MODULE – A module may be removed by removing any cables attached to top of the module and removing the hold-down screw (C) from the bottom. Rock the module slightly while lifting upward to free it from its chassis socket.

REINSTALLING MODULE – Before installing the module, check that all module pins are straight and properly aligned; then carefully seat the module pins into the chassis socket. Replace the module hold-down screw (C) to insure a good ground connection between the module and chassis, and replace any cables attached to the top of the module. Module cable connections are shown in Figure 5-6.

NOTE

If a module is replaced with a new module, it will be necessary to align the phase-locked loop or other circuits involved (see Table 5-3).

MODULE PIN NUMBERING SYSTEM – The module pins are numbered as shown in Figure 5-2. The off-center index stud prevents the module's being plugged in backwards, and also provides a method for locating pin 1.

NOTE

All 13 pins are not required in each module. Only the pins actually used are installed, but the numbering system remains the same.

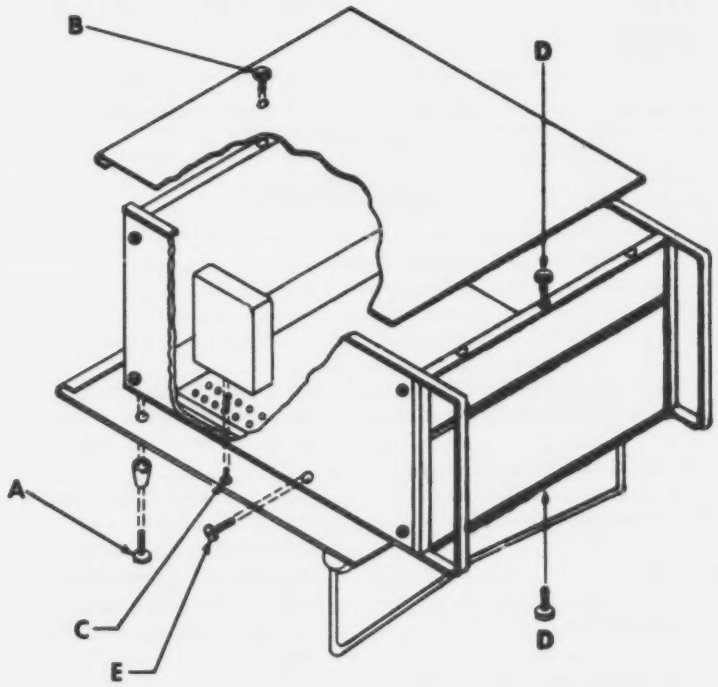


Figure 5-1. Disassembly

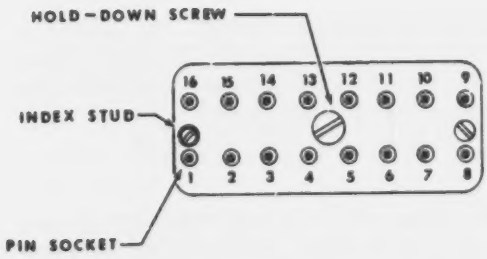


Figure 5-2. Module Pin Numbering

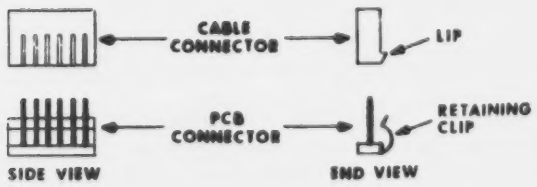


Figure 5-3. Connector Alignment

5.2.3 PRINTED-CIRCUIT BOARD SERVICING

PRINTED-CIRCUIT BOARD CONNECTORS – When reinstalling a cable connector on a printed-circuit board, be sure the connector is properly aligned with the board connector pins and that the connector faces the proper direction (see Figure 5-3).

METER BOARD (C315) REMOVAL – Removal of the Meter Board assembly requires that the Attenuator dial, OUTPUT VERNIER knob and potentiometer retaining nut, and front-top rail be removed. The Meter Board is secured to front panel by three screws – one through the front panel (behind Attenuator dial) and one at each top corner of Meter Board. Remove these three screws and disengage all slip-on wire connectors from the Attenuator mounted switch. Disengage the 6-pin connector from the Meter Board. The Meter Board assembly can then be moved toward the rear until the VERNIER potentiometer shaft, UNLEVELED lamp, and METER case clear the front panel. The board can then be lifted from the instrument.

The Meter Board is reinstalled by reversing the removal procedure. When installing the Meter Board, use care not to damage the UNLEVELED lamp.

MODULATION BOARD (C316-6) REMOVAL – The Modulation Board assembly can be removed by the following procedure: Disengage the slip-on connectors from the six BCD Lever/Indicator switches; disengage the twelve-pin connector from the Modulation Board; remove the front-bottom rail; unsolder the wire from EXT modulation connector and remove retaining nut from the backside of this BNC connector; remove the black spring-loaded knobs from MODULATION MODE and FREQ switches; remove the knob from the FREQ VERNIER pot shaft; remove the front-top rail; then remove one screw from the top-left corner of the Modulation Board and one screw from the top-left corner of the Meter Board. The Modulation Board assembly can now be angled until the switch levers clear the front panel. The assembly can then be lifted from the instrument.

The assembly is reinstalled by reversing the removal procedure.

NOTE

When placing connectors on Lever/Indicator switches, be sure each connector is on correct switch; the switch cables break out of the main harness in the same order that the switches appear.

POWER SUPPLY BOARD REMOVAL – The Power Supply board and heatsink can be removed by removing the four screws which secure the printed circuit board to the instrument rear panel. After removal of the connecting harness, the board can be carefully lifted from the instrument. The Power Supply board is reinstalled by reversing the removal procedure.

5.2.4 RECOMMENDED TEST EQUIPMENT

The test equipment numbered (1) through (8) in Table 4-1 is recommended for servicing, troubleshooting and aligning the instrument.

5.3 ALIGNMENT PROCEDURE

Remove the instrument top and bottom covers and M172 module cover. Allow a two-hour warmup period before aligning.

In general, alignment should be performed in the sequence given. Refer to Figures 5-4, 5-5, and 5-6 for test point and adjustment locations.

NOTE

All measurements are made with reference to chassis ground.

5.3.1 +18 VOLT ADJUSTMENT

Connect the digital voltmeter to the orange +18 volt line on pin 3 of module M30-8. Set +18 V Adj on the Power Supply to produce +18.00 V.

5.3.2 -18 VOLT ADJUSTMENT

Connect the digital voltmeter to the yellow -18 volt line on pin 4 of module M30-8. Set -18 V Adj on the Power Supply to produce -18.00 V.

5.3.3 +7.3 VOLT CHECK

Connect the digital voltmeter to the green +7.3 volt line on pin 2 of module M30-8. The reading must be +7.3 V ±150 mV.

5.3.4 CRYSTAL FREQUENCY ADJUSTMENT M30-8

Connect a frequency counter with a 50 ohm input to the instrument RF connector. Set the signal generator Lever/Indicator switches to a high frequency which is within the

counter's range, such as 500 MHz. Set the front-panel controls as follows:

FREQ VERNIER	CAL
MODULATION MODE	CW
MODULATION FREQ	EXT
MODULATION FM/AM	minimum
OUTPUT VERNIER	Full cw
OUTPUT Step Attenuator	+10 dBm
METER FUNCTION	OUTPUT

Adjust the M30-8 Frequency Adjust trimmer (Figure 5-5) for a minimum-frequency indication on the counter, then carefully turn the Frequency Adjust trimmer clockwise until the counter indicates the frequency selected by Lever/Indicator switches. Disconnect the counter from the RF OUT connector. A final frequency check will be covered in Section 5.3.12.

5.3.5 PHASE-LOCKED LOOP 1 ADJUSTMENT M31A

No adjustment of module M31A is necessary.

5.3.6 PHASE-LOCKED LOOP 2 ADJUSTMENT M32A-2

See Figure 5-5 for location of M32A-2 test points and Figure 5-6 for adjustment controls. Set the Lever/Indicator switches to 200.000 MHz and all other front-panel controls as in Section 5.3.4. Connect a digital voltmeter to M32A-2 pin 14. This voltage should be between +0.5 and +2.5 VDC. If it is not, carefully adjust both Crystral Reference trimmers (A and B) to produce a minimum reading on the voltmeter. Set the Lever/Indicator switches to 239.000 MHz and note that the DVM reading is still within the above limits.

Set the Lever/Indicator switches to 200.000 MHz and connect the scope vertical input (DC, 1 V/division) to M32A-2 pin 15. Adjust M32A-2 control (A) for a 0 V scope indication. Set the Lever/Indicator switches to 239.000 MHz and adjust M32A-2 control (B) to again produce a 0 V scope indication.

NOTE

Controls (C) and (D) on module M32A-2 are factory adjusted, and should not be readjusted during alignment.

5.3.7 PHASE-LOCKED LOOP 3 ADJUSTMENT

PLL 3 consists of two modules, M33-2 and M9W-5. The test point is on module M33-2 (Figure 5-5), while the adjustment controls are on module M9W-5 (Figure 5-6). Set the Lever/Indicator switches to 250.000 MHz and all other front-panel controls as in Section 5.3.4. Connect the scope vertical input (DC, 1 V/division) to M33-2 pin 5. Adjust M9W-5 control (D) for a 0 V scope indication. Set the front-panel controls as follows:

MODULATION MODE	FMx10
MODULATION FREQ	1 kHz
MODULATION FM/AM	Full up

Set the scope vertical input (on M33-2 pin 5) for AC, 50 mV/division. Adjust M9W-5 control (C) for minimum (null) indication of the 1 kHz sine wave on the scope.

5.3.8 PHASE-LOCKED LOOP 4 ADJUSTMENT

Calibration of PLL 4 involves three modules: M172, M9W-5, and M34-1. Test points are located on modules M172 and M34-1, while adjustment controls are located on modules M172 (see Figure 5-4) and M9W-5.

Set the Lever/Indicator switches to 250.000 MHz and all other front-panel controls as in Section 5.3.4. Connect a digital voltmeter to M172 pin 1; then, adjust M172 250 MHz Adj (R22) for a 0.00 V reading on the voltmeter. The voltmeter may now be disconnected.

Connect a frequency counter to the RF OUT connector and connect the scope vertical input (DC, 1 V/division) to M34-1 pin 8. Adjust M9W-5 control (A) for 0 ±1 V on the scope. The counter should indicate a frequency of 250 MHz.

NOTE

Due to the way the M34-1 locks on harmonics of 40 MHz, it is possible to adjust M9W-5 control (A) for 0 V at multiples of 40 MHz offset from 250 MHz. If this happens, it will be necessary to readjust M9W-5 control (A) several turns to break lock and relock at the next multiple of 40 MHz until 0 ±1 V can be obtained with a 250 MHz counter reading.

Set the output frequency to 300 MHz and adjust M172 300 MHz Adj (R28) for 0 ±3 V on the scope with a counter reading of 300 MHz. Repeat this step, using the applicable M172 Adj (R24, R30, and R34) for frequencies of 350, 400, and 450 MHz.

Set the Lever/Indicator switches to 500.000 MHz. Adjust M172 500 MHz Adj (R37) for a scope reading near 0 V. Increase the Lever/Indicator switch setting to 520.000 MHz and note the scope indication; then, adjust M172 500 MHz Adj to give scope indications at 500.000 and 520.000 MHz that are symmetrical about 0 V.

Set the Lever/Indicator switches to 100.000 MHz and adjust M172 100 MHz Adj (R13) for 0 ±3 V on the scope and a counter reading of 100 MHz. Repeat using the appropriate M172 Adj (R10 and R7) for frequencies of 50 and 0 MHz. Set (Lever/Indicator switches to 001.000 MHz for 0 MHz adjustment.)

Connect the digital voltmeter to M34-1 pin 14 (Leveler TP). Step through the frequency range from 1 to 520 MHz in 10 MHz steps to find the frequency having the highest leveler voltage, then adjust M9W-5 control (B) for +1.0 VDC at this frequency setting.

NOTE

Controls (B) and (C) on module M34-1 are factory adjusted, and should not be readjusted during alignment.

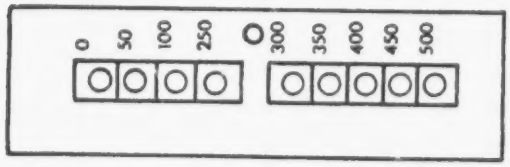


Figure 5-4. M172 Controls

5.3.9 PHASE-LOCKED LOOP 5 ADJUSTMENT

Adjustment controls for PLL 5 are located on Modulation Board C316-6 and module M29-2 (Figure 5-6), while the MOD TP is located on under side of the chassis (Figure 5-5). Connect a frequency counter to the front-panel RF OUT connector and a digital voltmeter to the MOD TP. Set the front-panel controls as follows:

FREQ VERNIER	0 kHz
Frequency selector	2.000 MHz
MODULATION MODE	FMx10
MODULATION FREQ	DC
MODULATION FM/AM	Full up
OUTPUT VERNIER	Full cw
OUTPUT Step Attenuator	+10 dBm

NOTE

Modulation Board C316-6 contains a Size Adj (C) and a Balance Adj (D) which are factory adjustments. DO NOT change the settings of these two controls.

Adjust Modulation Board control (A) for a +5.00 ±.01 V reading on the voltmeter. Set the MODULATION FM/AM slider full down. The voltmeter should indicate 0 V ±20 mV. Disconnect the voltmeter from the MOD TP.

Adjust M29-2 control (B) to produce a frequency counter reading of 2.000 MHz ±100 Hz. Set the MODULATION FM/AM slider full up and adjust M29-2 control (A) for a counter reading of 2.100 MHz ±100 Hz.

Set the MODULATION MODE to FMx1 and adjust Modulation Board control (B) for a counter reading of 2.010 MHz ±100 Hz.

5.3.10 METER BOARD ADJUSTMENT – C315

To adjust the output METER, the unit must rest on its bottom surface (normal operating position). Momentarily turn off power to the instrument and mechanically zero the output METER with the front-panel zero adjust screw. The METER needle should bisect the dot at the left end of the METER scale. Restore power to the instrument and allow it to stabilize.

Set the OUTPUT VERNIER fully ccw; then, adjust Meter Board pot (B) until the METER needle again bisects the dot at the left end of the METER scale. See Figure 5-6 for the locations of the Meter Board pots. Set the OUTPUT VERNIER completely cw and adjust Meter Board pot (A) for a +3 dBm output METER reading.

Set the front-panel controls as follows:

FREQ VERNIER	CAL
Frequency selector	50.000 MHz
MODULATION MODE	CW
MODULATION FREQ	N/A
MODULATION FM/AM	minimum
OUTPUT VERNIER	Full cw
OUTPUT Step Attenuator	+10 dBm

Calibrate the power meter and its thermistor or power sensor. Set the power meter to the +15 dBm range; then connect the thermistor or sensor to the instrument RF OUT connector.

Adjust Meter Board pot (F) for a +13 dBm power meter reading. Set the OUTPUT VERNIER for a -7 dB reading on the output METER and set the power meter to the +5 dBm range. Adjust Meter Board pot (E) for a +3 dBm power meter reading. Again set the power meter to the +15 dBm range and turn the OUTPUT VERNIER fully cw. Repeat this procedure until the +13 and +3 dBm power meter readings are obtained without further adjustment of Meter Board pots (E) and (F).

Set the OUTPUT Step Attenuator to 0 dBm and the power meter to the +5 dBm range. With the OUTPUT VERNIER completely cw, adjust Meter Board pot (C) for a +3 dBm power meter reading. Set the OUTPUT VERNIER for a -6 dBm reading on the output METER and set the power meter to the -5 dBm range. Adjust Meter Board pot (D) for a -6 dBm power meter reading. Repeat this procedure until the +3 and -6 dBm power meter readings are obtained without further adjustment of Meter Board pots (C) and (D).

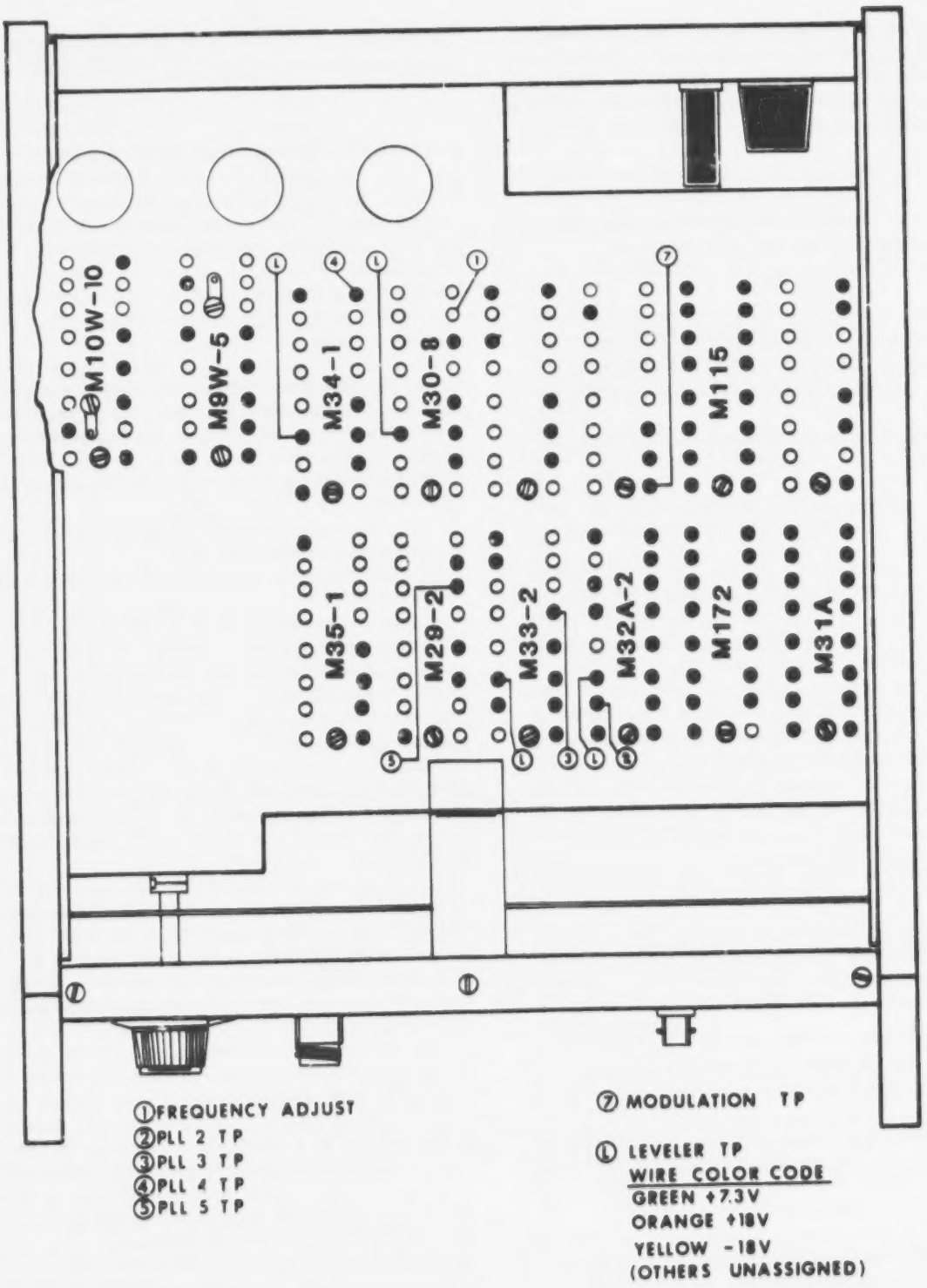


Figure 5-5. Bottom View

(1) DPS2C POWER SUPPLY
A – +18 V ADJ
B – -18 V ADJ
C – FUSE 2 AT

(2) NOT USED

(3) M116 DOWN CONV
A – 10 MHZ TP
B – GAIN ADJ

(4) NOT USED

(5) NOT USED

(6) M30-8 XTAL REF
A – 1440 MHZ ADJ
B – 1440 MHZ ADJ

(7) M34-1 WIDE OSC LOCK
A – RF TP
B – BALANCE
C – GAIN
D – UNLOCK INDICATOR

(8) M9W-6 SWEEP OSC
A – WIDE OSC CENT ADJ
B – WIDE OSC LEV ADJ
C – NARROW OSC SW ADJ
D – NARROW OSC LEV ADJ

(9) M10W-10 OUTPUT AMP

(10) M31A KHZ STEPS
A – UNLOCK INDICATOR

(11) M172 SWEEP DRIVE/DAC

(12) M32A-2 MHZ STEPS
A – 000 MHZ ADJ
B – 039 MHZ ADJ
C – GAIN
D – BALANCE
E – UNLOCK INDICATOR

(13) M33-2 NARROW OSC LOCK
A – RF TP
B – UNLOCK INDICATOR

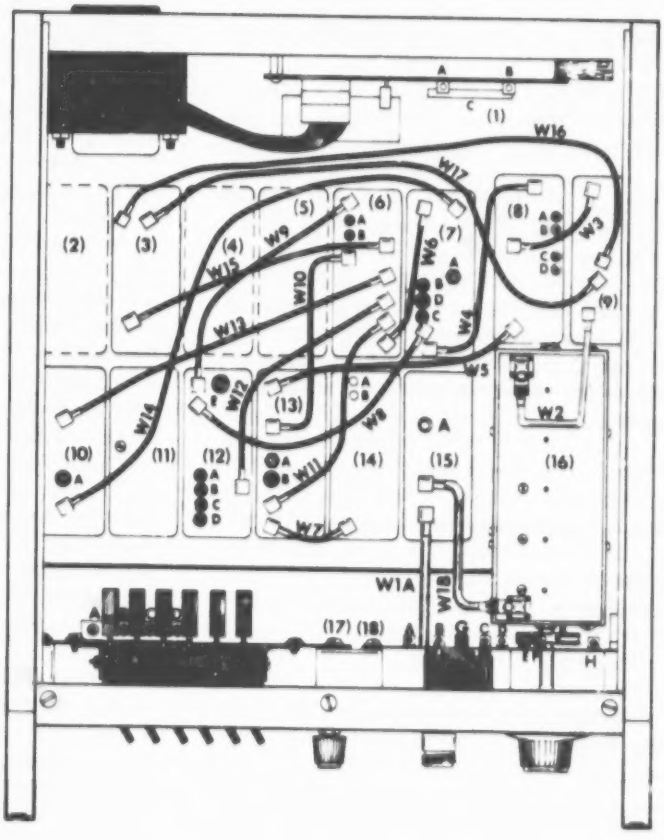
(14) M29-2 FM REF
A – 2.1 MHZ ADJ
B – 2 MHZ ADJ

(15) M35-2 RF CKT BKR
A – PUSH TO TEST

(16) 50120-01 STEP ATTEN

(17) C316-6 MODULATION BD
A – +5 V ADJ
B – FM x 1 ADJ
C – SIZE ADJ
D – BAL ADJ

SG-1170/U



(18) C315 METER BD
A – METER CAL ADJ
B – METER BAL ADJ
C – LEVEL 0 DBM RANGE +3 ADJ
D – LEVEL 0 DBM RANGE -7 ADJ
E – LEVEL +10 DBM RANGE +3 ADJ
F – LEVEL +10 DBM RANGE +13 ADJ
G – % AM ADJ +3 DBM
H – % AM ADJ -7 DBM

Figure 5-6. Top View

Using the test set-up of Figure 4-3, set the instrument front-panel controls as follows:

Frequency selector	520.000 MHz
MODULATION MODE	AM
MODULATION FREQ	DC
OUTPUT Step Attenuator	0 dBm
OUTPUT VERNIER	+3 dBm

Set the MODULATION FM/AM slider to produce a reading of 4.5 VDC at the MOD TP. Adjust Meter Board pot (G) for an average reading of 90% AM on the modulation meter. Set the OUTPUT VERNIER for a -7 dBm reading on the output METER and adjust Meter Board pot (H) for a 90% AM average reading on the modulation meter. Repeat this procedure until the 90% AM average readings are obtainad without further adjustment of Meter Board pots (G) and (H).

5.3.11 DOWN-CONVERSION ADJUSTMENT – M115

Set the instrument front panel controls as follows:

FREQ VERNIER	CAL
Frequency selector	001.000 MHz
MODULATION MODE	CW
MODULATION FREQ	N/A
MODULATION FM/AM	minimum
OUTPUT VERNIER	Full cw
OUTPUT Step Attenuator	0 dBm

Connect the power meter to the instrument RF OUT connector. Note the output level reading. Set the Lever/Indicator switches to 000.999 MHz, and adjust the M115 Gain control such that the output level exactly matches the level noted at 001.000 MHz.

5.3.12 FINAL FREQUENCY CHECK - M30-8

Connect frequency counter to the instrument RF OUT connector, and set the front-panel controls as specified in Section 5.3.4. Note the frequency reading on the counter. If it does not agree with the selected frequency within accuracy specifications, very carefully adjust the M30-8 Frequency Adjust trimmer (see Figure 5-5) until the desired frequency is obtained.

5.4 TROUBLESHOOTING

Effective troubleshooting requires a thorough understanding of the block diagrams and circuit description located in Section 3 of this manual; then the Performance Tests in Section 4 and Alignment Procedures in Section 5 will aid in localizing the trouble symptom to a particular module or PC board. Once this has been accomplished, the module or board can be replaced, or repaired with aid of the proper schematic and parts layout diagram. In general, it is preferable to replace a defective module or PC board assembly.

Equipment troubles are frequently due simply to improper control settings; therefore, before engaging in a troubleshooting procedure, be sure front-panel controls are set in proper operating position. Refer to the operating instructions in Section 2 of this manual for a complete explanation of each control's function along with typical operating instructions.

After verifying that the trouble is not improper setting of the controls or test setup, make a thorough visual inspection of the instrument for such obvious defects as loose or missing screws, broken wires, defective module-pin sockets, loose RF cables, and burned or broken components.

After localizing the problem, voltage and resistance checks will help locate the defective component.

For troubleshooting purposes, it is permissible to operate the instrument with any of the plug-in modules or RF cables removed; however, the instrument should be turned off when removing or installing modules.

RF cables can be disconnected from the module output connectors, and a power meter or spectrum analyzer connected directly to the module connector for power level or frequency measurements. Fabrication of a short SMC to BNC adaptor cable will facilitate connection of test equipment.

The front-panel ACCURACY lamps together with the four internal module "unlock indicator" lamps aid in troubleshooting phase-locked loop problems. One module in each loop contains an indicator lamp which lights to indicate when that loop is unlocked. The lamps indicate only which loops are unlocked, not which module is at fault.

A problem in the Power Supply may cause many symptoms pointing to other areas and should be checked when the symptom does not clearly indicate a specific problem. Loss of the -18 V supply, for example, will cause the ACCURACY lamp to flash; while loss of the +18 V supply will extinguish all lamps. The +18, -18, and +7.3 V supplies comprise the DPS2C Power Supply which forms the rear panel of the instrument. Performance of these supplies is indicated in Section 5.3.

5.4.1 TROUBLESHOOTING HINTS

Following is a list of several typical symptoms, accompanied by the possible cause(s) or a troubleshooting procedure. It is assumed the instrument has been properly calibrated previously, and that a warmup period will precede troubleshooting.

INTERMITTENT OPERATION – Defective module-pin sockets or loose RF cables.

LOW RF OUTPUT (+10 dBm RANGE) – If power is 10 dB low on this range, but is correct on the 0 dBm range, micro-switch S1 mounted on the Step Attenuator is defective, is not being actuated by the Attenuator shaft, or a switch wire is disconnected.

LOW OR NO RF OUTPUT (ANY RANGE) – Defective Attenuator or RF cables connecting to input or output of Attenuator, defective Meter Board, defective module M10W-10, M9W-5, or M35-2.

Check the voltage on pin 15 of module M10W-10. With the OUTPUT VERNIER fully clockwise, the voltage should be approximately as follows: -2.5 VDC on the +10 dBm range; -0.7 VDC on the 0 dBm range. These voltages indicate proper operation of the Meter Board; while other values, particularly positive voltages, indicate a defective IC or other problem on the Meter Board.

Next, check RF power directly at the M10W-10 output. If it is correct, the trouble lies in the Attenuator or its RF cables. If the module M10W-10 output is low, measure the module M9W-5 RF output – this should be approximately -10 to -11 dBm. If this level is correct, module M10W-10 is defective; while if the level is low, Sweep Oscillator M9W-5 is defective.

OUTPUT METER DOES NOT MOVE – If the METER is pegged at either end of scale, the trouble is probably a defective component on Meter Board C315; while if the METER remains at mechanical zero, the METER movement may be open or a Meter Board component may be defective.

UNLEVELED LAMP ON – RF OUT connector not terminated in 50 ohm load, AM percentage set so that peak of modulated output exceeds +13 dBm, defective module M10W-10, defective Attenuator or connecting RF cables.

Connect a power meter directly to the M10W-10 output. Set the OUTPUT Step and VERNIER controls for a +13 dBm reading on the power meter at 50.000 MHz. Step through the 10 to 520 MHz frequency range in 10 MHz steps. A power meter reading of +13 dBm ±0.5 dB with the UNLEVELED lamp off indicates proper operation of module M10W-10. If the output is correct at M10W-10, but the UNLEVELED lamp is on, the trouble is probably a defective lamp driver circuit in module M10W-10. With proper operation of module M10W-10, connect the power meter directly to the Step Attenuator output and repeat the above steps. If the Attenuator output is correct, the trouble is due to a defective RF cable or possibly a poor ground connection at the RF OUT connector.

ACCURACY LAMP FLASHES CONTINUOUSLY – A steady light in CW mode but flashing in FM modes indicates a defective M29-2 or M33-2 module. If the ACCURACY lamp flashes in all modes, one or more of the phase-locked loops is open; see Phase-Locked Loop Troubles below.

NOTE

Above the normal frequency range of the instrument (in the vicinity of 560 MHz), it is normal for phase-locked loop 4 to unlock, causing the ACCURACY lamp to flash.

PHASE-LOCKED LOOP TROUBLES – An open or unlocked loop, indicated by a lighted module lamp, can be caused by a number of factors, including: low AC input voltage, low DC supply voltages, improper phase-locked loop DC voltages, an open or shorted RF cable, or a defective module.

A defective RF cable or module can have a "chain-reaction" effect that causes two or more loops to unlock. For example, loss of the 1 kHz signal to module M31A will cause PLL 1 to unlock; thus, module M31A may not supply a proper signal to module M34-1, causing PLL 4 to unlock. Failure of the 40 MHz Crystal Oscillator in module M30-8 will cause all loops to unlock, since all six reference frequencies will be lost.

Table 5-1 lists typical RF signal-input levels for each of the phase-locked loops. Those signals having a TTL level or 1 V level may be measured with a high-frequency oscilloscope; the other signals are best measured with a spectrum analyzer (dBm), or a 50 ohm detector and calibrated scope (mV).

Table 5-1. PHASE-LOCKED LOOP RF-SIGNAL LEVELS

P.L.L.	MODULE	INPUT-SIGNAL FREQUENCY	INPUT-SIGNAL LEVEL dBm (mV)	MEASURED AT
1	M31A	1 kHz	TTL	M30-8 (W13)
2	M32A-2	1 MHz	TTL	M30-8 (W12)
		1440 MHz	-12 to -15 dBm (20 mV)	M30-8 (W9)
3 & 5	M33-2	1198 MHz	-10 dBm ±3 dB (150 m V)	M9W-5 (W5)
		1200 MHz (120 comb)	-15 dBm ±5 dB (75 mV)	M30-8 (W10)
		2 kHz	TTL	M30-8 (W11)
		1.9 to 2.1 MHz	1 volt pp	M29-2 (W7)
4	M34-1	1198 to 1718 MHz	-10 dBm ±5 dB (25 mV)	M9W-5 (W4)
		1448 to 1487 MHz	-2 dBm ±3 dB (200 mV)	M32A-2 (W8)
		40 to 280 MHz (40 comb)	-10 dBm ±3 dB (1 V)	M30-8 (W6)
		10 to 9.001 MHz	TTL	M31A(W14)

PHASE-LOCKED LOOP 1 – Unlocking of this loop may be caused by a defective module M31A, module M30-8 or RF cable connecting M30-8 to M31A.

If the M31A unlock indicator is on, check the 1 kHz signal as listed in Table 5-1. If the 1 kHz signal is correct, module M30-8 is operating properly. Check the RF cable between M30-8 and M31A. If the proper 1 kHz signal is being applied to the M31A, check for +7.3 V on pin 6, +18 V on pin 7, and -18 V on pin 8 of M31A. If the input signal and DC voltages are correct, module M31A is defective.

PHASE-LOCKED LOOP 2 – Unlocking of loop 2 can be caused by defective modules M172, M30-8, M32A-2 or RF cables connecting M30-8 to M32A-2.

Connect a digital voltmeter to M32A-2 pin 11 and observe the readings while stepping through the 200 to 239 MHz frequency range in 1 MHz steps. The voltmeter reading should change -0.2 V per MHz from 0 V at 200 MHz to -7.8 V at 239 MHz. These voltages indicate proper operation of module M172.

Module M30-8 can be checked by measuring the 1 MHz and 1440 MHz signals directly at the M30-8. The levels specified in Table 5-1 indicate proper operation of module M30-8. Check connectors and RF cables connecting M30-8 to module M32A-2. Check for +18 V on pin 7, -18 V on pin 8, and +7.3 V on pin 9 of M32A-1. If all input signals and DC voltages to module M32A-2 are normal, but the M32A-2 LED is on, module M32A-2 is defective.

PHASE-LOCKED LOOPS 3 and 5 – The LED indicator on module M33-2 serves both PLL 3 and PLL 5. If the M33-2 LED is on, determine which loop is defective by switching the FREQUENCY VERNIER out of CAL position. If the M33-2 LED goes off, the trouble is in PLL 5; if the LED stays on, the trouble is in PLL 3.

Table 5-2. Frequency Switch BCD

Decimal Digit	BCD 8 4 2 1
0	– – – –
1	– – – G
2	– – G –
3	– – G G
4	– G – –
5	– G – G
6	– G G –
7	– G G G
8	G – – –
9	G – – G

NOTE: G = Wire Grounded By Switch. – = Wire Not Grounded.

PLL 3 consists of modules M33-2 and M9W-5. It is possible that PLL 3 can be restored to operation simply by re-aligning per Section 5.3.7, and this should be attempted. If adjusting M9W-5 control (D) has no effect on the M33-2 pin 5 voltage, the problem is in module M33-2; however, if the pin 5 voltage changes but phase lock cannot be established, or if the pin 5 voltage cannot be set to within 5 volts of 0 V, the trouble is in module M9W-5. Measure the M33-2 Leveler TP (pin 14) voltage. If it is +0.5 to 5 VDC, the trouble is probably in module M33-2; however, if it is greater than 5 VDC, the trouble is probably in module M9W-5 or M30-8. Check the M30-8 reference frequencies and M9W-5 output level as shown in Table 5-1 to determine which module is defective.

PLL 5 consists of modules M29-2 and M33-2. With the FREQ VERNIER in CAL position, measure the PLL 5 voltage on M29-2 pin 6. Adjust M29-2 control (B) for 0 V on pin 6. If, while adjusting the M29-2 from 1.9 to 2.1 MHz this voltage does not move, the problem is in module M33-2. If the voltage adjusts, but will not stay locked, the trouble is in module M29-2.

PHASE-LOCKED LOOP 4 – Unlocking of loop 4 may, under certain conditions, be caused by problems originating in the other loops. Therefore, loops 1, 2, and 3 should be operating properly before troubleshooting loop 4.

Unlocking of loop 4 can be caused by defective modules M172, M9W-5, M30-8, M31A, M32A-2, M34-1, or connecting RF cables.

Connect a digital voltmeter to M172 pin 1. The voltmeter reading should be 0.00 V with the output frequency set to 000 MHz, -2.5 V at 250 MHz, and -5.0 V at 500 MHz. Connect the voltmeter to M172 pin 8. The voltmeter reading should be +5 to +8 V at 000 MHz, 0 V at 250 MHz, and -8 to -10 V at 500 MHz. If these voltages are obtained, module M172 is operating properly.

Measure the Wide Oscillator signal at module M9W-5. The frequency will be between 1198 MHz and 1718 MHz, depending upon the Lever/Indicator switch setting. If the signal level is as specified in Table 5-1, module M9W-5 is probably operating correctly.

Measure the 40 comb line at module M30-8. The 40 MHz harmonics from 40 MHz to 280 MHz should be fairly equal in amplitude and the level should be as specified in Table 5-1. This level indicates proper operation of the M30-8 module.

Measure the 1448 to 1487 MHz signal at module M32A-2. The exact frequency is dependent upon the "MHz" switch setting. If the level is as specified in Table 5-1, the M32A-2 is operating properly.

Next, measure the 10 to 9.001 MHz output of the M31A module. The output frequency will be 10.000 MHz with the "kHz" switches set to 000, and will decrease to 9.001 MHz with the "kHz" switches set to 999. If the signal level is as specified in Table 5-1, module M31A is operating properly.

If the output of each of the above modules is correct, check the connectors and RF cables connecting modules M9W-5, M31A, M32A-2, and M30-8 to module M34-1. Check for +7.3 V on pin 2, +18 V on pin 3, and -18 V on pin 4 of module M34-1. If all input signals and DC voltages to module M34-1 are correct, but the M34-1 module lamp is on, module M34-1 is probably defective, but the trouble could be caused by module M9W-5.

A further check of the M34-1 can be made by monitoring M34-1 pin 8 with a digital voltmeter while stepping through the 10 MHz to 520 MHz frequency range in 10 MHz steps. The voltmeter reading should be 0 ±3 V; however, a defective M34-1 may give a voltage reading of 12 to 16 V.

LEVER/INDICATOR SWITCHES – Troubles in the BCD switch circuits may be caused by a defective switch, a loose or disengaged switch connector, a broken switch wire, or, possibly, a defective M115.

Five of the switches utilize four wires plus a ground to select decimal digits from 0 through 9. The 100's MHz switch uses three wires plus ground, since it needs only to select digits between 0 and 5. A "BCD Truth Table", applicable to each of the six switches, is given in Table 5-2.

Suspected switch problems can be checked by referring to Table 5-2 and the instrument Wiring Diagram to determine which module pins are grounded for a particular frequency. For example, to select a frequency of 200.500 MHz, M172 pin 3 is grounded by selecting digit 2 on the 100's MHz switch, and M31A pins 2 and 4 are grounded by digit 5 on the 100's kHz switch.

If only the 10 MHz programming is in error, the trouble may be a defective IC3 in module M115.

DOWN-CONVERSION TROUBLES – Problems in the down-conversion circuitry (modules M115 and M10W-10) can cause a variety of problems.

If the instrument operates properly from 1 to 520 MHz, but not from 1 to 999 kHz, the problem probably lies in either module M115 or M10W-10. Check for the TTL "turn-on" signal at pin 5 of the M10W-10. If the signal is correct (0 V above 1 MHz, 3 V below 1 MHz), check to see that the RF signal is being switched to the M115 for output frequencies below 1 MHz. If the switch is working, the problem lies in either the M115 or a connecting cable. If the instrument output frequency is 10 MHz higher than

the programmed frequency (for example, 10.520 MHz instead of 520 kHz), and the TTL signal at pin 5 of module M10W-10 is correct, the switch is not working, and the problem lies in the M10W-10.

If the instrument operates properly from 1 to 999 kHz, but not above 1 MHz, check for the TTL signal at pin 5 of module M10W-10. If it is correct, the problem lies in the M10W-10.

If the RF output level from 450 to 999 kHz is too low, and cannot be corrected by realignment, the problem lies in either the M115 or a connecting cable.

MODULATION TROUBLES – The Modulation Board (C316-6) is the most common cause of modulation problems, particularly when the modulating signal is lost. Non-linear amplitude modulation at higher-audio frequencies from an external source may be caused by the M10W-10 Output Amplifier.

Set the front-panel controls as follows to determine the presence of modulating signal:

FREQ VERNIER	CAL
MODULATION MODE	AM
MODULATION FREQ	400 Hz
MODULATION FM/AM	maximum
OUTPUT VERNIER	Full cw
OUTPUT Step Attenuator	0 dBm

Connect the oscilloscope vertical input to the rear-panel MOD TP. The scope should display a 10 Vpp sine wave at a frequency of 400 Hz (2.5 msec period). Set the MODULATION FREQ switch to 1 kHz. The scope display should be a 10 Vpp sine wave with a period of 1 msec. If the 10 V signals are not obtained, check for +7.3 V on pin 8, +18 V on pin 1, and -18 V on pin 2 of the C316-6 Modulation Board. If the DC voltages are normal, the Modulation Board is defective.

AM TROUBLES – Connect the scope vertical input to the wiper of Meter Board pot (G) and check for the 10 Vpp sine wave. Presence of the sine wave at this point indicates proper operation of the Modulation Board and its wiring. If the 10 Vpp sine wave is not present at pot (G), the problem is a broken wire in the harness or a defective MODULATION MODE switch.

Connect the scope vertical input to the bottom contact of the micro switch mounted on the Step Attenuator and check for a sine wave having an approximate amplitude of 1.75 Vpp. If the 1.75 V signal is not present, check for +18 V on pin 6 and -18 V on pin 5 of the Meter Board. If the DC voltages are normal, Meter Board C315 is defective.

Check for a 1.75 Vpp sine wave on pin 15 of module M10W-10. If the sine wave is normal at this point, but amplitude modulation is abnormal, module M10W-10 is defective.

FM TROUBLES – Set the MODULATION MODE to FMx10 and check for a 10 Vpp sine wave at pin 16 of module M29-2. A 400 Hz or 1 kHz 10 V sine wave at this point indicates proper operation of the Modulation Board and its wiring. If the sine wave is not present, the problem is most likely a defective Modulation Board, a broken wire in the harness, or a defective MODULATION MODE switch.

Remove the RF cable from the top of module M29-2, and check for a 1 Vpp 1.9 to 2.1 MHz signal at this connector. If this signal is not present, check for +18 V on pin 3 and -18 V on pin 4 of module M29-2. If the DC voltages are normal, FM problems are caused by a defective module M29-2. If the 1.9 to 2.1 MHz signal is present at the M29-2 connector, FM problems are probably caused by a defective M33-2 module.

5.4.2 ASSEMBLY REPLACEMENT

While in many cases the instrument will work satisfactorily after simply replacing a defective assembly, to maintain the high accuracy of which the unit is capable, assembly replacement should be followed by alignment of the affected circuits. Table 5-3 lists each assembly and the adjustment needed.

Table 5-3. Assembly Replacement Alignment

ASSEMBLY REPLACED	ADJUSTMENT REQUIRED (See indicated sections in Alignment Procedure)
M172 Sweep Drive/DAC	Reset Phase-Locked Loop 4 (5.3.8)
M9W-5 Sweep Oscillator	Reset Phase-Locked Loops 3 and 4 (5.3.7 and 5.3.8)
M10W-10 Output Amplifier	Realign C315 Meter Board (5.3.10)
M35-2 RF Circuit Breaker	None Required
M29-2 FM Reference	Reset Phase-Locked Loop 5 (5.3.9)
M30-8 Crystal Reference	Adjust Crystal Frequency (5.3.4 and 5.3.12)
M31A kHz Steps	None Required
M32A-2 MHz Steps	Adjust Phase-Locked Loop 2 (5.3.6)
M33-2 Narrow Osc. Lock	Adjust Phase-Locked Loop 3 (5.3.7)
M34-1 Wide Osc. Lock	Set M34-1 pin 14 for +1.0 VDC (5.3.8)
M115 Down Converter	Adjust Gain Calibration (5.3.11)
C315 Meter Board	Adjust Meter Board Calibration (5.3.10)
C316-6 Modulation Board	Adjust Phase-Locked Loop 5 (5.3.9)
DPS2C Power Supply	Adjust ±18 V and check 7.3 V (5.3.1-5.3.3)

best copy available

5.5 PREVENTIVE MAINTENANCE CHECKS AND SERVICES

Preventive maintenance is the systematic care, servicing, and inspection of equipment to prevent the occurence of trouble, to reduce downtime, and to maintain the equipment in serviceable condition. Defects that cannot be corrected must be reported to personnal at a higher maintenance category.

Routine checks like: cleaning, dusting, washing, checking for frayed cables, storing items not in use, covering unused receptacles, and checking for loose nuts and bolts are not listed as preventive maintenance checks or services. They are things that you should do anytime you see they must be done.

Preventive maintenance checks and services for the instrument are required before use and annually. These checks must be performed during the specified interval.

OPERATOR/CREW PREVENTATIVE MAINTENANCE CHECKS AND SERVICES

B-Before D-During A-After W-Weekly M-Monthly Q-Quarterly

Item No.	Interval B	D	A	W	M	Q	Item to be Inspected	Procedures Check for and have repaired or adjusted as necessary
1	•						Physical Condition	Check for physical damage to instrument
2	•	•					Mechanical Operation	Check mechanical operation of all switches and controls
3	•	•					Electrical Operation	Check for suitable output per Section 2.6

ORGANIZATIONAL PREVENTIVE MAINTENANCE CHECKS AND SERVICES

B-Before
D-During
A-After
W-Weekly
M-Monthly
Q-Quarterly

Item No.	Interval B	D	A	W	M	Q	Item to be Inspected	Procedures Check for and have repaired or adjusted as necessary
1						•	Publications	See that all publications are complete, serviceable, and current
2						•	Knobs and Bulbs	Check condition of knobs and bulbs-replace if necessary
3						•	Operation	Perform Performance Tests given in Section 4

5.6 CLEANING

Inspect the exterior surfaces of the signal generator; exterior surfaces should be clean, free of dust, grease and fungus.

a. Remove dust and loose dirt with a clean, soft cloth.

WARNING

Adequate ventilation should be provided while using TRICHLOROTRIFLUOROETHANE. Prolonged breathing of vapor should be avoided. The solvent should not be used near heat or open flame; the products of decomposition are toxic and irritating. Since TRICHLOROTRIFLUOROETHANE dissolves natural oils, prolonged contact with skin should be avoided. When necessary, use gloves which the solvent cannot penetrate. If the solvent is taken internally, consult a physician immediately.

b. Remove grease fungus, and ground-in dirt from the case; use a cloth dampened (not wet) with trichlorotrifluoroethane NSN 6850-00-984-5853.

c. Remove dust or dirt from connectors with a brush.

d. Clean the front panel and control knobs; use a soft, clean cloth. If dirt is difficult to remove, dampen the cloth with water; use mild soap if necessary.

5.7 TOUCHUP PAINTING

Remove rust and corrosion from metal surfaces by lightly sanding them with fine sandpaper. Brush two thin coats of paint on the bare metal to protect it from further corrosion. Refer to applicable cleaning and refinishing practices specified in TB43-0118.

SECTION 6

SCHEMATICS

6.1 INTRODUCTION

This section contains all schematics for the instrument. A schematic index is given in Section 6.3.

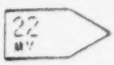
6.2 SCHEMATIC NOTES

The following notes and abbreviations pertain to all schematics. Additional notes pertaining to specific schematics are included on each schematic if required.

Unless otherwise noted, resistor values are given in ohms, capacitor values are given in pF, and inductor values are given in μH.

SYMBOL NOTES

Denotes DC voltage reading unless otherwise specified.



Denotes high-impedance crystal detector reading in volts unless otherwise specified.

Denotes 50 ohm crystal detector reading in volts unless otherwise specified.

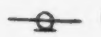
Signal or voltage source.

Connects to indicated signal or voltage source.

Arrow indicates clockwise rotation of wiper.

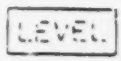
Coaxial jack

Coaxial plug

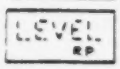


Coaxial cable

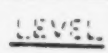
Factory adjusted part.



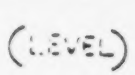
Denotes a front-panel device.



Denotes a rear-panel device.



Denotes a printed circuit board adjustment or accessible module adjustment.



Denotes an internal module adjustment not accessible without removing module cover.

ABBREVIATION CODE

A	ampere
AC	alternating current
C	capacitor
ccw	counterclockwise
CR	diode
CW	continuous wave
cw	clockwise
dB	decibel
dBc	dB referred to carrier
dBm	dB referred to 1 mW
dBmV	dB referred to 1 mV
DC	direct current
DS	indicating device, lamp
F	farad
F.P.	front panel
H	henry
Hz	hertz
IC	integrated circuit
IF	intermediate frequency
J	jack
K	relay
kHz	kilohertz
kΩ	kilohm
kV	kilovolt
kW	kilowatt
L	inductor
M	meter
MHz	megahertz
MΩ	megohm
mA	milliampere
mH	millihenry
mV	millivolt
mW	milliwatt
μF	microfarad
μA	microampere
μH	microhenry
Ω	ohm
OC	opto-coupler
P	plug
p	peak
pp	peak-to-peak
pF	picofarad
Q	transistor
R	resistor
RF	radio frequency
RMS	root-mean-square
R.P.	rear panel
S	switch
T	transformer
T.P.	test point
V	volt
VA	voltampere
W	watt
X	crystal

SCHEMATIC REFERENCES

A	assembly
C	capacitor
CR	diode
F	fuse
IC	integrated circuit
J	jack
K	relay
L	inductor
M	meter
MX	mixer
OC	opto-coupler
P	plug
Q	transistor
R	resistor
S	switch
T	transformer
V	vacuum tube
X	crystal
W	cable assy

SCIENTIFIC PREFIXES

G = giga (10^9)	k = kilo (10^3)	m = milli (10^{-3})
M = mega (10^6)	c = centi (10^2)	μ = micro (10^{-6})
		p = pico (10^{-12})

APPENDIX A

REFERENCES

DA Pam 310–1	Consolidated Index of Army Publications and Blank Forms.
SB 38-100	Preservation, Packaging, Packing and Marking Materials, Supplies, and Equipment Used by the Army.
TB 43-0118	Field Instructions for Painting and Preserving Electronics Command Equipment Including Camouflage Pattern Painting of Electrical Equipment Shelters.
TB 43-180	Calibration Requirements for the Maintenance of Army Materiel.
DA Pam 738-750	The Army Maintenance Management System (TAMMS)
TM 750-244-2	Procedures for Destruction of Electronics Materiel to Prevent Enemy Use (Electronics Command).
TM 11-6625-3029-24P	Organizational, Direct Support and General Support Maintenance Repair Parts and Special Tools List (Including Depot Maintenance Repair Parts and Special Tools) for Signal Generator SG-1170/U. (To be published)

APPENDIX D

MAINTENANCE ALLOCATION

Section 1. INTRODUCTION

D-1. General.

This appendix provides a summary of the maintenance operations for Signal Generator SG-1170/U. It authorizes categories of maintenance for specific maintenance functions or repairable items and components, and the tools and equipment required to perform each function. This appendix may be used as an aid in planning maintenance operations.

D-2. Maintenance Function.

Maintenance functions will be limited to and defined as follows:

a. Inspect. To determine the serviceability of an item by comparing its physical, mechanical, and/or electrical characteristics with established standards through examination.

b. Test. To verify serviceability and to detect incipient failure by measuring the mechanical or electrical characteristics of an item and comparing those characteristics with prescribed standards.

c. Service. Operations required periodically to keep an item in proper operating condition, i.e., to clean (decontaminate), to preserve, to drain, to paint, or to replenish fuel, lubricants, hydraulic fluid, or compressed air supplies.

d. Adjust. To maintain, within prescribed limits, by bringing into proper or exact position, or by setting the operating characteristics to the specified parameters.

e. Align. To adjust specified variable elements of an item to bring about optimum or desired performance.

f. Calibrate. To determine and cause corrections to be made or to be adjusted on instruments, or test measuring and diagnoistic equipments used in precision measurement. Consists of comparisons of two instruments, one of which is a certified standard of known accuracy, to detect and adjust any discrepancy in the accuracy of the instrument being compared.

g. Install. The act of emplacing, seating, or fixing into position an item, part, module (component or assembly) in a manner to allow the proper functioning of the equipment or system.

h. Replace. The act of substituting a serviceable like type part, subassembly, or module (component or assembly) for an unserviceable counterpart.

i. Repair. The application of maintenance services (inspect, test, service, adjust, align, calibrate, replace) or other maintenance actions (welding, grinding, riveting, straightening, facing, remachining, or resurfacing) to restore serviceability to an item by correcting specific damage, fault, malfunction, or failure in a part, subassembly, module (component or assembly), end item, or system.

j. Overhaul. That maintenance effort (service/action), necessary to restore an item to a completely serviceable/operational condition as prescribed by maintenance standards (i.e., DMWR) in appropriate technical publications. Overhaul is normally the highest degree of maintenance performed by the Army. Overhaul does not normally return an item to like-new condition.

k. Rebuild. Consists of those services/actions necessary for the restoration of unserviceable equipment to a like-new condition in accordance with original manufacturing standards. Rebuild is the highest degree of materiel applied to Army equipment. The rebuild operation includes the act of returning to zero those age measurements (hours, miles, etc.) considered in classifying Army components.

D-3. Column Entries.

a. Column 1, Group Number. Column 1 lists group numbers, the purpose of which is to identify components, assemblies, subassemblies, and modules with the next higher assembly.

b. Column 2, Component/Assembly. Column 2 contains the noun names of components, assemblies, subassemblies, and modules for which maintenance is authorized.

c. Column 3, Maintenance Functions. Column 3 lists the functions to be performed on the items listed in column 2. When items are listed without maintenance functions, it is solely for purpose of having the group numbers in the MAC and RPSTL coincide.

d. Column 4, Maintenance Category. Column 4 specifies, by the listing of a "work time" figure in the appropriate subcolumn(s), the lowest level of maintenance authorized to perform the function listed in column 3. This figure represents the active time required to perform that maintenance function at the indicated category of maintenance. If the number or complexity of the tasks within the listed maintenance function vary at different maintenance categories, appropriate "work time" figures will be shown for each category. The number of task-hours specified by the "work time" figure represents the average time required to restore an item (assembly, subassembly, component, module, end item or system) to a serviceable condition under typical field operating conditions. This time includes preparation time, troubleshooting time, and quality assurance/quality control time in addition to the time required to perform the specific tasks identified for the maintenance functions authorized in the maintenance allocation chart. Subcolumns of column 4 are as follows:

C – Operator/Crew
O – Organizational
F – Direct Support
H – General Support
D – Depot

e. Column 5, Tools and Equipment. Column 5 specifies by code, those common tools sets (not individual tools) and special tools, test, and support equipment required to perform the designated functions.

f. Column 6, Remarks. Column 6 contains an alphabetic code which leads to the remark in Section IV, Remarks, which is pertinent to the item opposite the particular code.

D-4. Tool and Test Equipment Requirements (Sect. III).

a. Tool or Test Equipment Reference Code. The numbers in this column coincide with the numbers used in the tools and equipment column of the MAC. The numbers indicate the applicable tool or test equipment for the maintenance functions.

b. Maintenance Category. The codes in this column indicate the maintenance category allocated the tool or test equipment.

c. Nomenclature. This column lists the noun name and nomenclature of the tools and test equipment required to perform the maintenance functions.

d. National/NATO Stock Number. This column lists the National/NATO stock number of the specific tool or test equipment.

e. Tool Number. This column lists the manufacturer's part number of the tool followed by the Federal Supply Code for Manufacturers (5-digit) in parentheses.

D-5. Remarks (Sect. IV).

a. Reference Code. This code refers to the appropriate item in Section II, column 6.

b. Remarks. This column provides the required explanatory information to clarify items appearing in Section II.

SECTION II MAINTENANCE ALLOCATION CHART
FOR

SIGNAL GENERATOR SG-1170/U

(1) GROUP NUMBER	(2) COMPONENT/ASSEMBLY	(3) MAINTENANCE FUNCTION	(4) MAINTENANCE CATEGORY					(5) TOOLS AND EQPT.	(6) REMARKS
			C	O	F	H	D		
00	Signal Generator SG-1170/U P/N 1010-00-0206	Inspect		0.2				Visual	
		Install		0.2				17	A
		Replace		0.2				17	
		Test				2.0		1 thru 18	B
		Repair				8.0		1 thru 18	
		Calibrate				3.5		1 thru 18	
		Inspect					0.2	18	C
		Test					2.0	1 thru 18	C
		Repair					8.0	1 thru 18	C
		Calibrate					3.5	1 thru 18	C
01	Power Supply P/N 1115-00-0028	Adjust				0.4		1	
		Repair				0.7		1, 18	D

SECTION III TOOL AND TEST EQUIPMENT REQUIREMENTS
FOR
SIGNAL GENERATOR SG-1170/U

TOOL OR TEST EQUIPMENT REF CODE	MAINTENANCE CATEGORY	NOMENCLATURE	NATIONAL/NATO STOCK NUMBER	TOOL NUMB
1	H, D	Digital Multimeter AN/USM-451	6625-00-168-0585	
2	H, D	Distortion Analyzer AN/URM-184	6625-00-871-8012	
3	H, D	Frequency Counter AN/USM-459	6625-02-061-8928	
4	H, D	Function Generator AN/USM-256	6625-00-087-4499	
5	H, D	Power Meter ME-441/U	6625-00-436-4883	
6	H, D	Modulation Meter ME-57A/U	6625-00-647-3737	
7	H, D	Oscilloscope AN/USM-281C	6625-00-106-3622	
8	H, D	Spectrum Analyzer IP-1216(P)/GR	6625-00-424-4370	
9	H, D	Attenuator Pads 10,20,30,40,dB CN-608	6625-00-623-5895	
10	H, D	Wide Band Amplifier AM-3495/U	6625-00-385-8891	
11	H, D	Signal Generator SG-1179/U	6625-01-120-3501	
12	H, D	VSWR Bridge AN/URM-120A/U	6625-01-039-1488	
13	H, D	Co Axial Short HP 11511A	5935-00-937-6255	
14	H, D	Co Axial Terminator HP 908A	5905-00-581-4285	
15	H, D	50 OHM LOAD HP 11503A	5905-00-890-3393	
16	H, D	Loop Probe	No NSN	
17	O	Tool Kit TK-101/U	5180-00-064-5178	
18	H, D	Tool Kit TK-100/G Tool Kit TK-105/G	5180-00-605-0079 5180-00-610-8177	

SECTION IV. REMARKS

REFERENCE CODE	REMARKS
A	Replace knobs, fuses and bulbs.
B	Repair includes replacement of all circuit card assemblies (modules) which are to be discarded.
C	Conduct performance test on equipment in storage over 6 months. If failure occurs, perform test, repair and calibrate functions before fielding.
D	REPAIR TO THE EXTENT OF REPLACING THE FOLLOWING:

ITEM	FSCM	PART NO.	NSN
CIRCUIT CARD ASSEMBLY	34280	1218-00-0250	6625-01-128-3086
FUSE, CARTRIDGE	81349	F03B250VIA	5920-00-636-0963
ADAPTER	05245	6J1	6625-01-035-9155
TRANSFORMER, POWER	12715	9158	5950-01-G25-1865

APPENDIX E

EXPENDABLE SUPPLIES AND MATERIAL LIST

Section I. INTRODUCTION

E-1. SCOPE

This appendix lists expendable supplies and materials you will need to operate and maintain the instrument. These items are authorized to you by CTA 50-970, Expendable Items (Except Medical, Class V, Repair Parts, and Heraldic Items).

E-2. EXPLANATION OF COLUMNS

a. Column (1) - Item Number. Not used.

b. Column (2) - Level. This column identifies the lowest level of maintenance that requires the listed item.

(enter as applicable)

C — Operator/Crew
O — Organizational Maintenance
F — Direct Support Maintenance
H — General Support Maintenance

c. Column (3) - National Stock Number. This is the National stock number assigned to the item; use it to request or requisition the item.

d. Column (4) - Description. Indicates the Federal item name and, if required, a description to identify the item. The last line for each item indicates the Federal Supply Code for Manufacturers (FSCM) in parentheses, followed by the part number.

e. Column (5) - Unit of Measure (U/M). Indicates the measure used in performing the actual maintenance function. This measure is expressed by a two-character alphabetical abbreviation (e.g., ea, in, pr). If the unit of measure differs from the unit of issue, requisition the lowest unit of issue that will satisfy your requirements.

SECTION II. EXPENDABLE SUPPLIES AND MATERIALS

(1) Item Number	(2) Level	(3) National Stock Number	(4) Description	(5) U/M
	0	6850-00-984-5853	Trichlorotrifluoroethane	GL

RECOMMENDED CHANGES TO EQUIPMENT TECHNICAL PUBLICATIONS

THEN . . JOT DOWN THE DOPE ABOUT IT ON THIS FORM. CAREFULLY TEAR IT OUT. FOLD IT AND DROP IT IN THE MAIL!

SOMETHING WRONG WITH THIS PUBLICATION?

FROM (PRINT YOUR UNIT'S COMPLETE ADDRESS)
Commander
Stateside Army Depot
ATTN: AMSTA-US
Stateside, N.J. 07703

DATE SENT
10 July 1975

PUBLICATION NUMBER	PUBLICATION DATE	PUBLICATION TITLE
TM 11-5840-340-12	23 Jan 74	Radar Set AN/PRC-76

BE EXACT. PIN-POINT WHERE IT IS

PAGE NO	PARAGRAPH	FIGURE NO	TABLE NO	IN THIS SPACE TELL WHAT IS WRONG AND WHAT SHOULD BE DONE ABOUT IT:
2-25	2-28			Recommend that the installation antenna alignment procedure be changed throughout to specify a 2^{o} IFF antenna lag rather than 1^{o}. REASON: Experience has shown that with only a 1^{o} lag, the antenna servo system is too sensitive to wind gusting in excess of 25 knots, and has a tendency to rapidly accelerate and decelerate as it hunts, causing strain to the drive train. Hunting is minimized by adjusting the lag to 2^{o} without degradation of operation.
3-10	3-3		3-1	Item 5, Function column. Change "2 db" to "3db." REASON: The adjustment procedure the the TRANS POWER FAULT indicator calls for a 3 db (500 watts) adjustment to light the TRANS POWER FAULT indicator.
5-6	5-8			Add new step f.1 to read, "Replace cover plate removed in step e.1, above." REASON: To replace the cover plate.
		FO3		Zone C 3. On J1-2, change "+24 VDC to "+5 VDC." REASON: This is the output line of the 5 VDC power supply. +24 VDC is the input voltage.

SAMPLE

PRINTED NAME, GRADE OR TITLE, AND TELEPHONE NUMBER	SIGN HERE
SSG I. M. DeSpiritof 999-1776	SSG I. M. DeSpiritof

DA FORM 1 JUL 79 2028-2 PREVIOUS EDITIONS ARE OBSOLETE.

P.S.--IF YOUR OUTFIT WANTS TO KNOW ABOUT YOUR RECOMMENDATION MAKE A CARBON COPY OF THIS AND GIVE IT TO YOUR HEADQUARTERS

RECOMMENDED CHANGES TO EQUIPMENT TECHNICAL PUBLICATIONS

THEN...JOT DOWN THE DOPE ABOUT IT ON THIS FORM. CAREFULLY TEAR IT OUT, FOLD IT AND DROP IT IN THE MAIL.

SOMETHING WRONG WITH THIS PUBLICATION?

FROM: (PRINT YOUR UNIT'S COMPLETE ADDRESS)

DATE SENT

PUBLICATION NUMBER	PUBLICATION DATE	PUBLICATION TITLE
	January 1983	

BE EXACT PIN-POINT WHERE IT IS

PAGE NO.	PARA-GRAPH	FIGURE NO.	TABLE NO.

IN THIS SPACE TELL WHAT IS WRONG AND WHAT SHOULD BE DONE ABOUT IT:

PRINTED NAME GRADE OR TITLE AND TELEPHONE NUMBER

SIGN HERE

DA FORM 1 JUL 79 2028-2

PREVIOUS EDITIONS ARE OBSOLETE

P.S.--IF YOUR OUTFIT WANTS TO KNOW ABOUT YOUR RECOMMENDATION MAKE A CARBON COPY OF THIS AND GIVE IT TO YOUR HEADQUARTERS.

REVERSE OF DA FORM 2028-2

FILL IN YOUR UNIT'S ADDRESS

FOLD BACK

DEPARTMENT OF THE ARMY

OFFICIAL BUSINESS

Commander
US Army Communications-Electronics Command
and Fort Monmouth
ATTN: DRSEL-ME-MP
Fort Monmouth, New Jersey 07703

RECOMMENDED CHANGES TO EQUIPMENT TECHNICAL PUBLICATIONS

THEN...JOT DOWN THE DOPE ABOUT IT ON THIS FORM. CAREFULLY TEAR IT OUT, FOLD IT AND DROP IT IN THE MAIL.

SOMETHING WRONG WITH THIS PUBLICATION?

FROM: (PRINT YOUR UNIT'S COMPLETE ADDRESS)

DATE SENT

PUBLICATION NUMBER	PUBLICATION DATE	PUBLICATION TITLE
	January 1983	

BE EXACT PIN-POINT WHERE IT IS

PAGE NO.	PARA-GRAPH	FIGURE NO.	TABLE NO.

IN THIS SPACE TELL WHAT IS WRONG AND WHAT SHOULD BE DONE ABOUT IT:

PRINTED NAME GRADE OR TITLE AND TELEPHONE NUMBER

SIGN HERE

DA, FORM 1 JUL 79 2028-2

PREVIOUS EDITIONS ARE OBSOLETE

P.S.--IF YOUR OUTFIT WANTS TO KNOW ABOUT YOUR RECOMMENDATION MAKE A CARBON COPY OF THIS AND GIVE IT TO YOUR HEADQUARTERS.

TEAR ALONG PERFORATED LINE

REVERSE OF DA FORM 2028-2

FOLD BACK

DEPARTMENT OF THE ARMY

OFFICIAL BUSINESS

Commander
US Army Communications-Electronics Command
and Fort Monmouth
ATTN: DRSEL-ME-MP
Fort Monmouth, New Jersey 07703

RECOMMENDED CHANGES TO EQUIPMENT TECHNICAL PUBLICATIONS

THEN...JOT DOWN THE DOPE ABOUT IT ON THIS FORM. CAREFULLY TEAR IT OUT, FOLD IT AND DROP IT IN THE MAIL.

SOMETHING WRONG WITH THIS PUBLICATION?

FROM: (PRINT YOUR UNIT'S COMPLETE ADDRESS)

DATE SENT

PUBLICATION NUMBER	PUBLICATION DATE	PUBLICATION TITLE
	January 1983	

BE EXACT PIN-POINT WHERE IT IS

PAGE NO.	PARAGRAPH	FIGURE NO.	TABLE NO.

IN THIS SPACE TELL WHAT IS WRONG AND WHAT SHOULD BE DONE ABOUT IT:

PRINTED NAME GRADE OR TITLE AND TELEPHONE NUMBER

SIGN HERE

DA FORM 1 JUL 79 2028-2

PREVIOUS EDITIONS ARE OBSOLETE

P.S.--IF YOUR OUTFIT WANTS TO KNOW ABOUT YOUR RECOMMENDATION MAKE A CARBON COPY OF THIS AND GIVE IT TO YOUR HEADQUARTERS.

TEAR ALONG PERFORATED LINE

REVERSE OF DA FORM 2028-2

FILL IN YOUR UNIT'S ADDRESS

FOLD BACK

DEPARTMENT OF THE ARMY

OFFICIAL BUSINESS

Commander
US Army Communications-Electronics Command
and Fort Monmouth
ATTN: DRSEL-ME-MP
Fort Monmouth, New Jersey 07703

By Order of the Secretary of the Army:

E. C. MEYER
General, United States Army
Chief of Staff

Official:

ROBERT M. JOYCE
Major General, United States Army
The Adjutant General

Distribution:

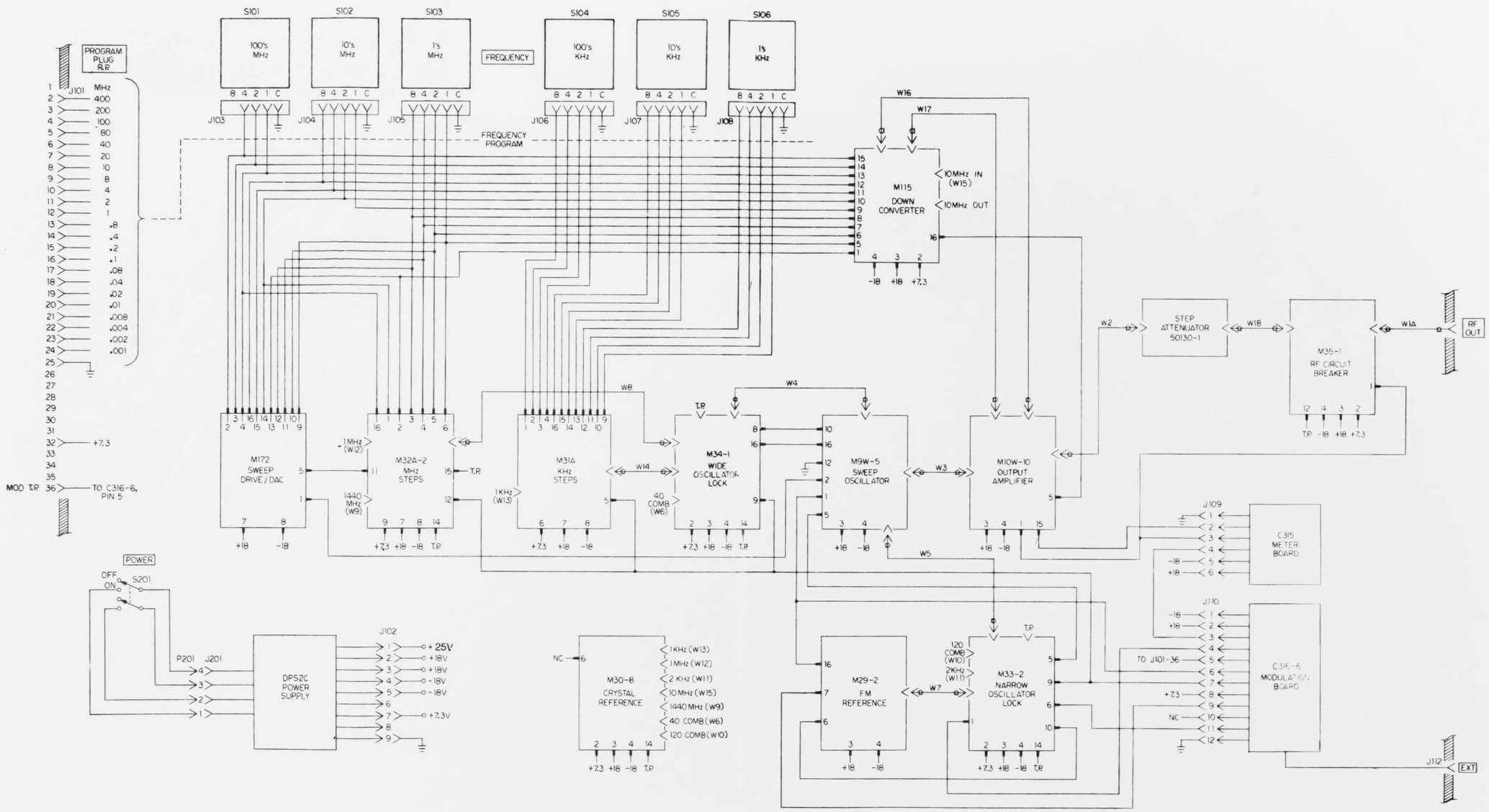
To be distributed in accordance with DA Form 12-34B, requirements for TMDE/Calibration Maintenance Manuals.

* U. S. GOVERNMENT PRINTING OFFICE : 1990 0 - 261-862 (20895)

Charts Transposed to

End of Volume.

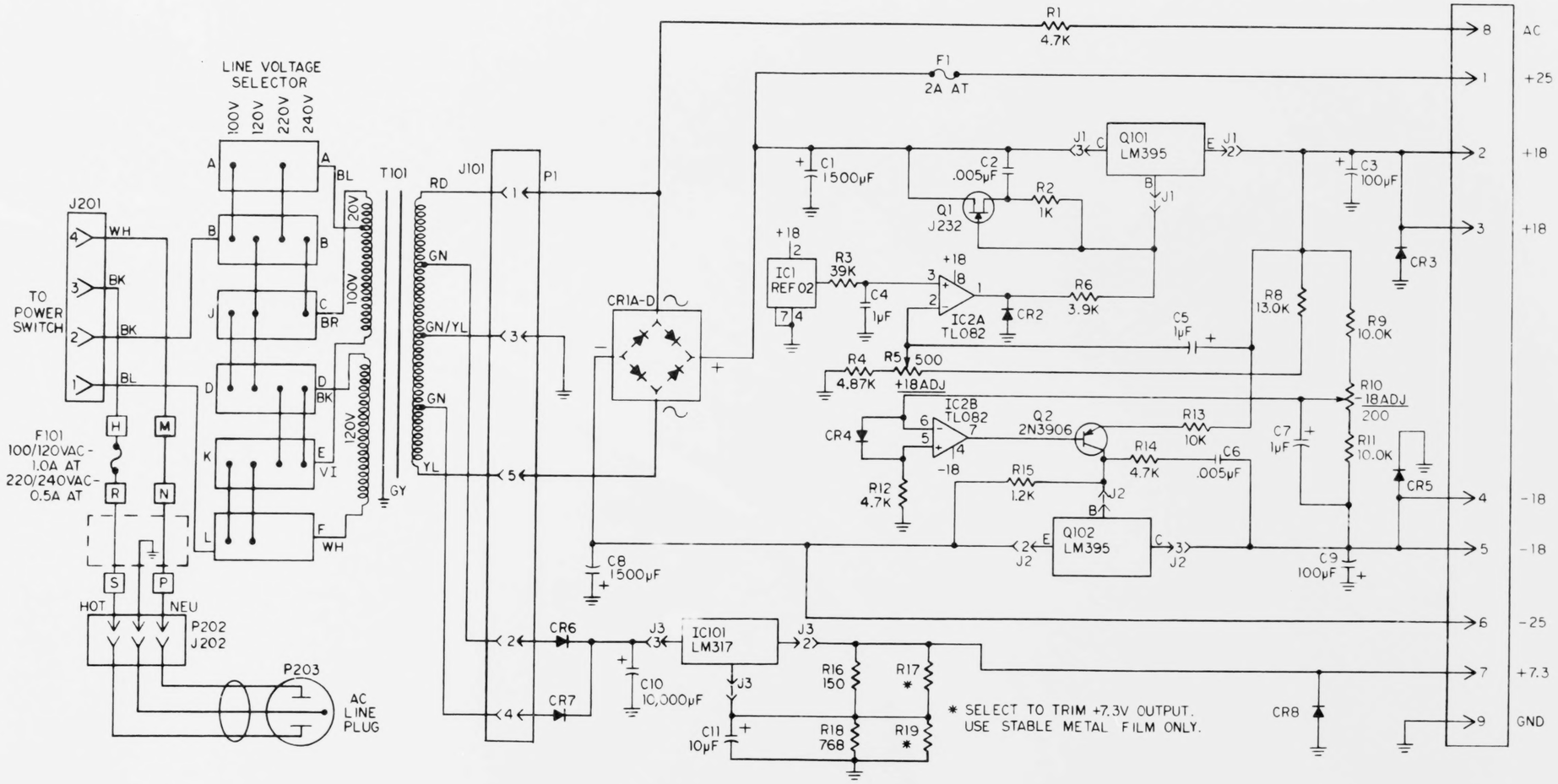
PIN : 052373-000



EL8NS001

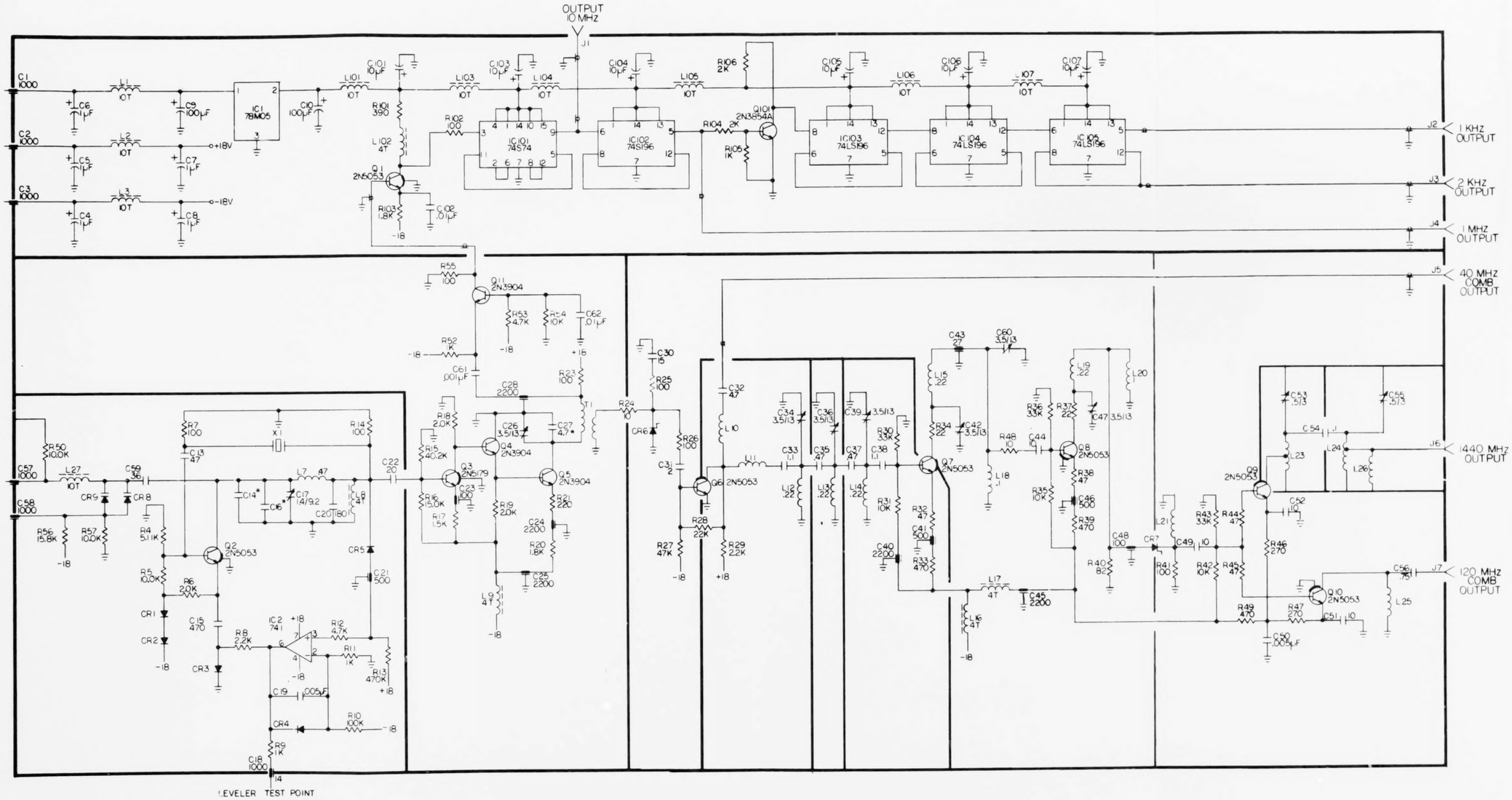
FIGURE FO-1, WIRING DIAGRAM

best copy available



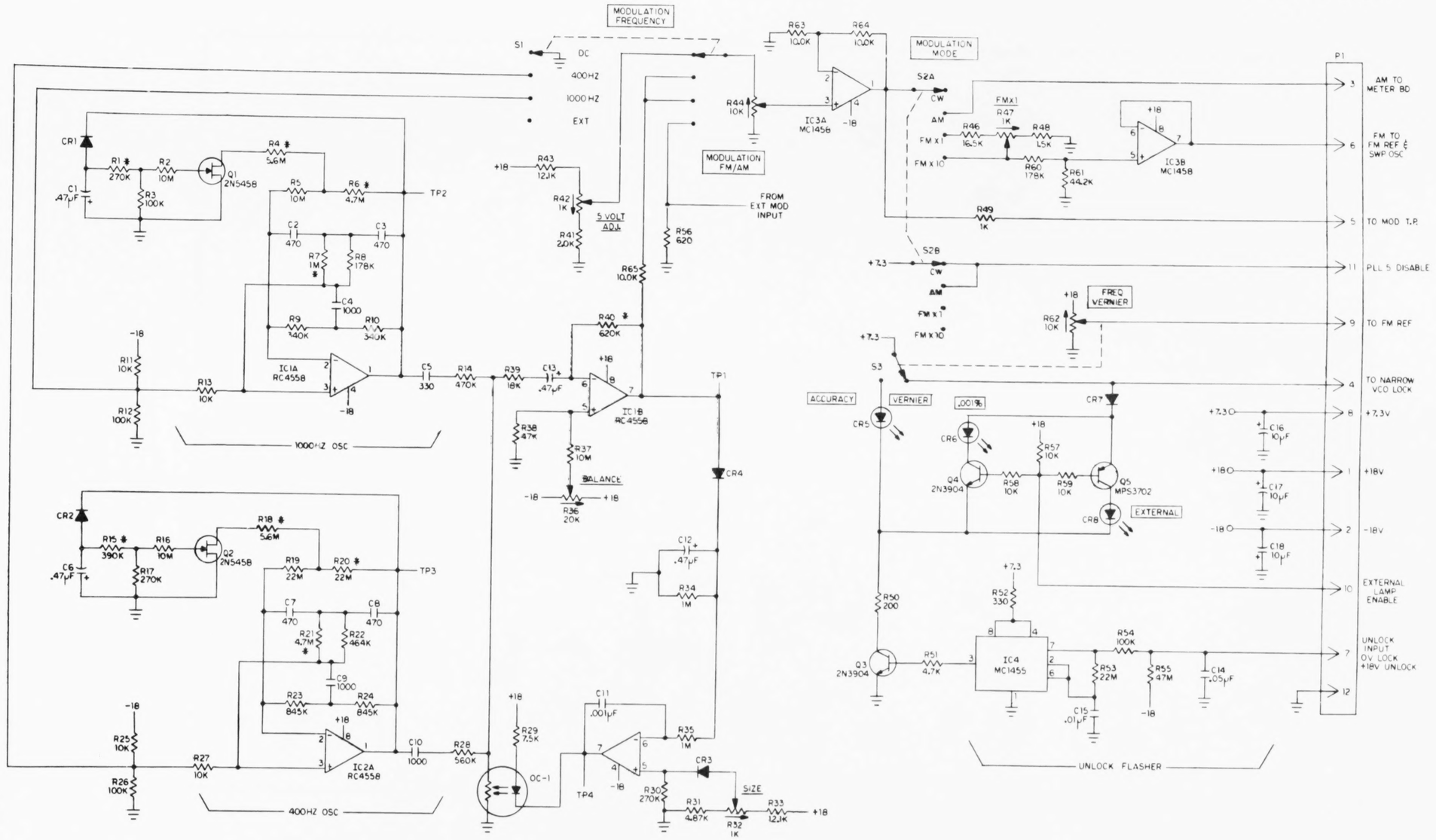
EL8NS002

FIGURE FO-2, DPS2C POWER SUPPLY



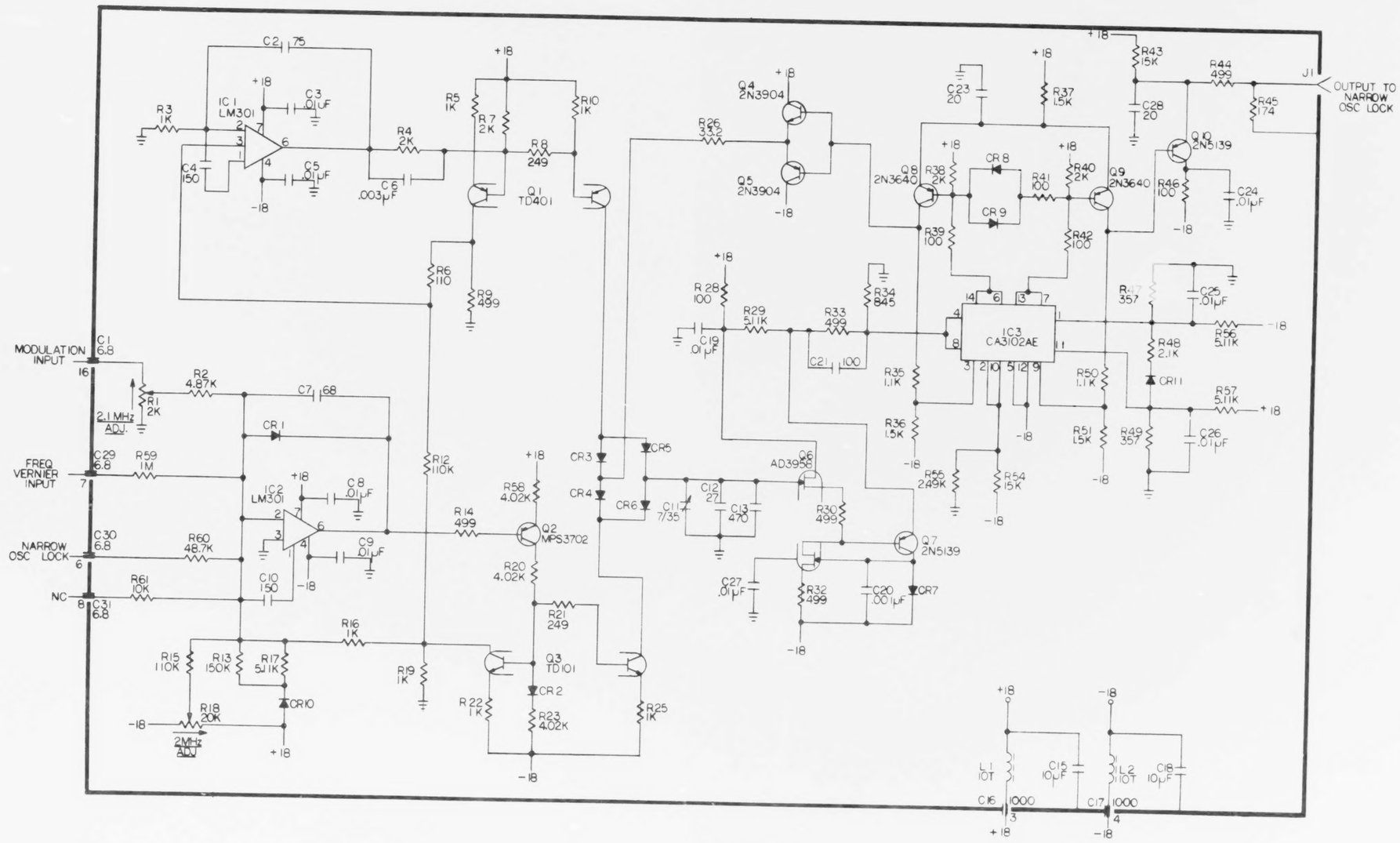
EL8NS003

FIGURE FO-3, M30-8 CRYSTAL REF



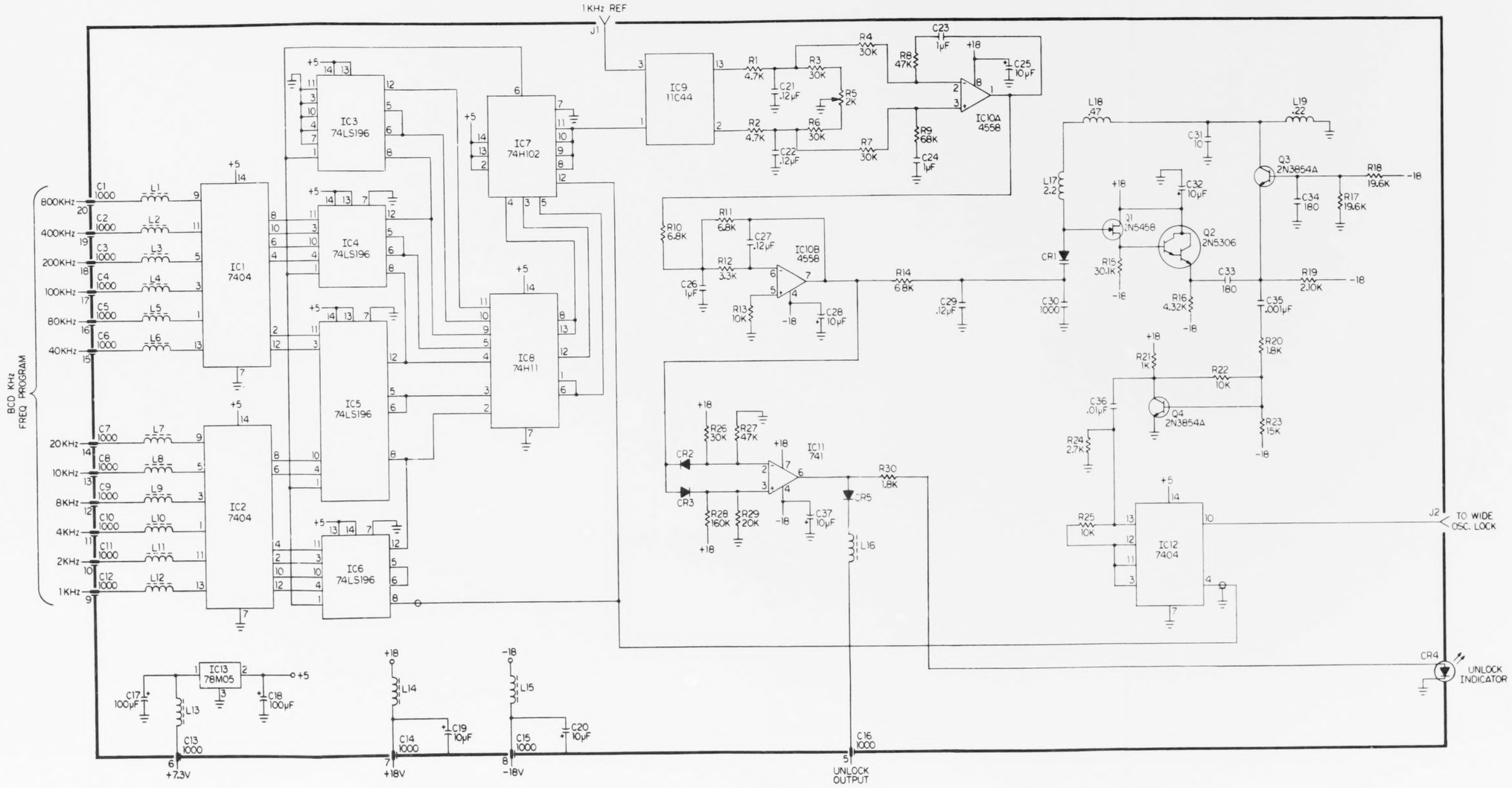
EL8NS004

FIGURE FO-4, C316-6 MOD BOARD



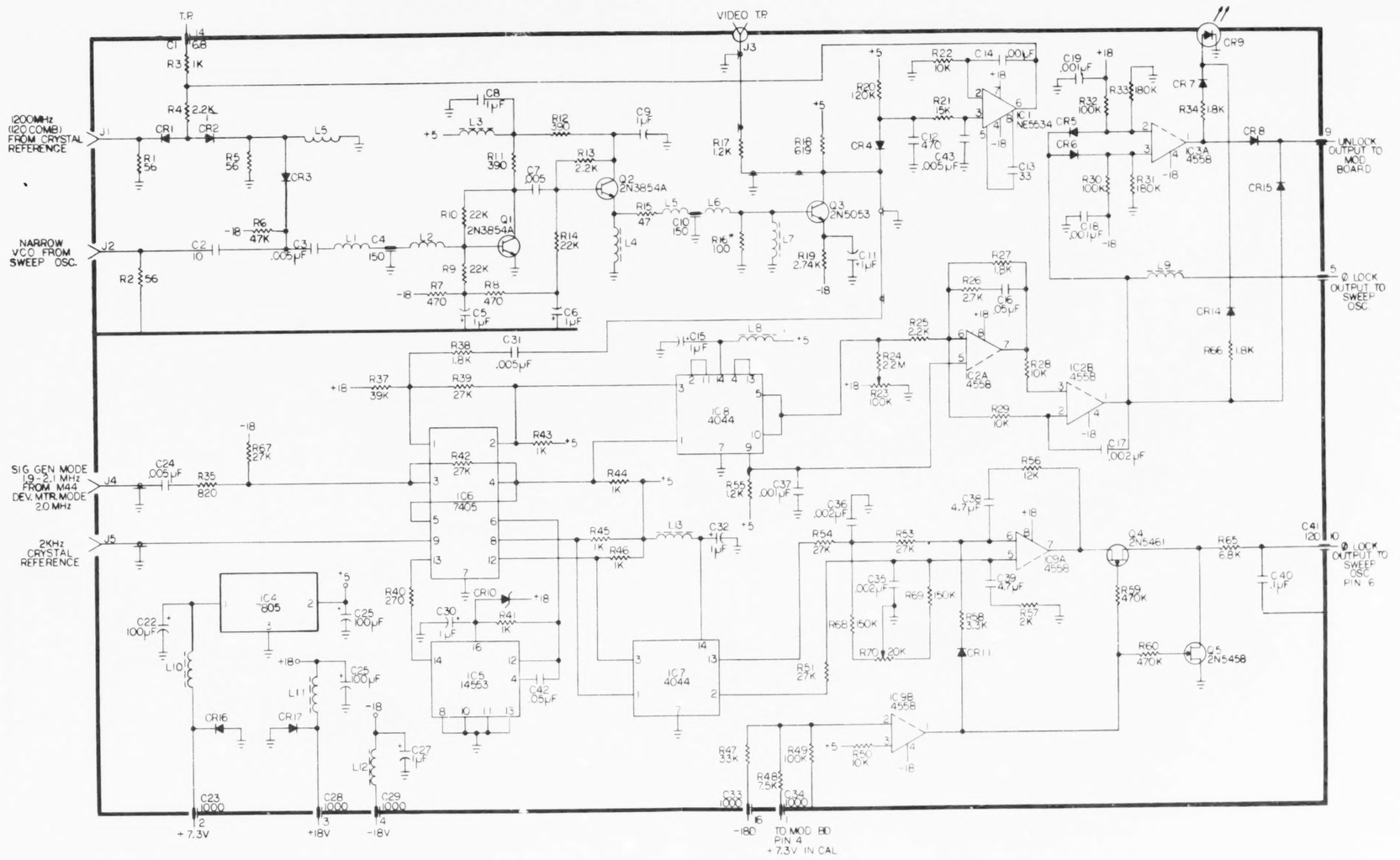
EL8NS005

FIGURE FO-5, M29-2 FM REFERENCE



EL8NS006

FIGURE FO-6, M31A KHz STEPS



EL8NSC07

FIGURE FO-7, M33-2 NARROW OSC LOCK

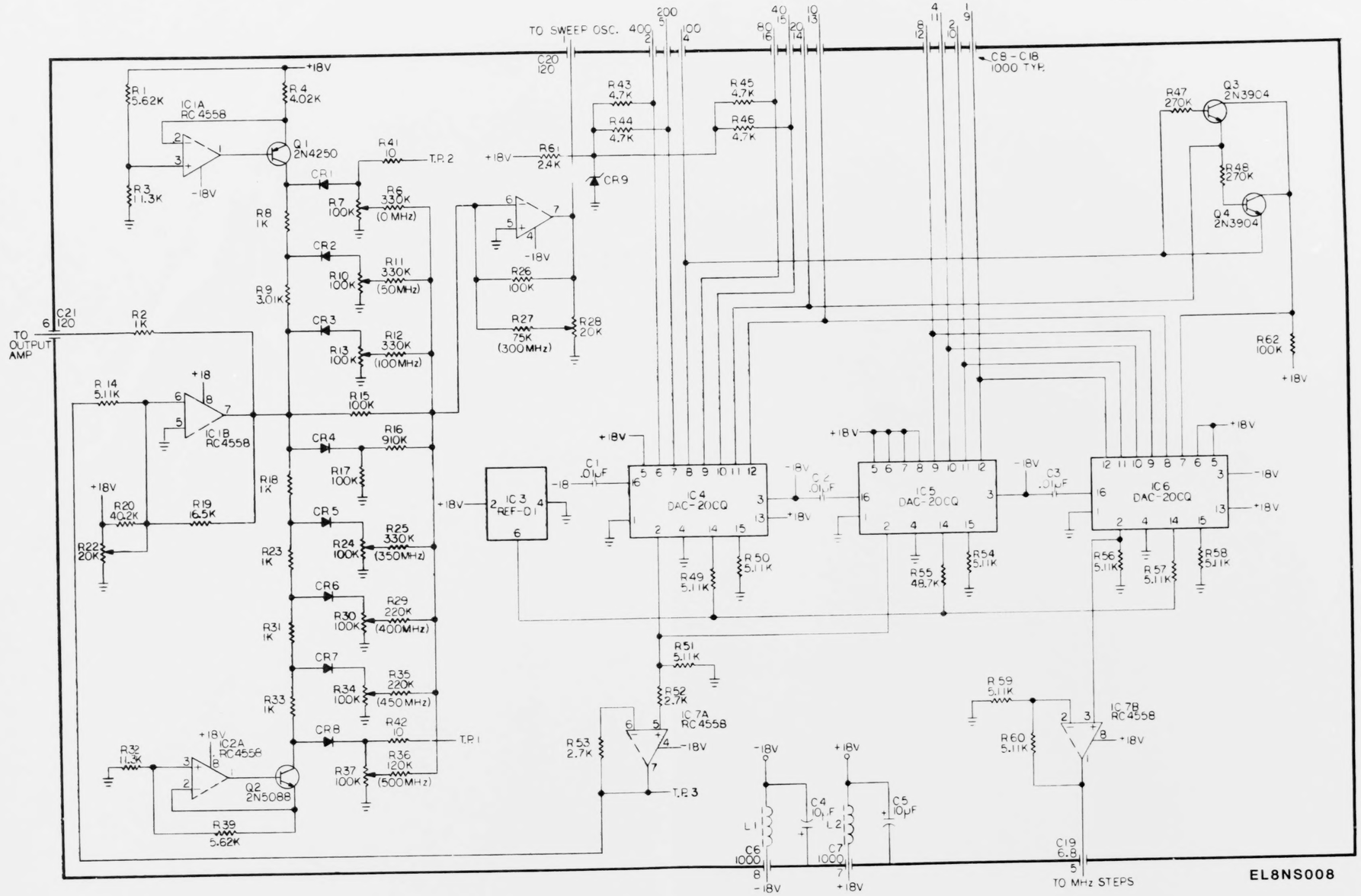
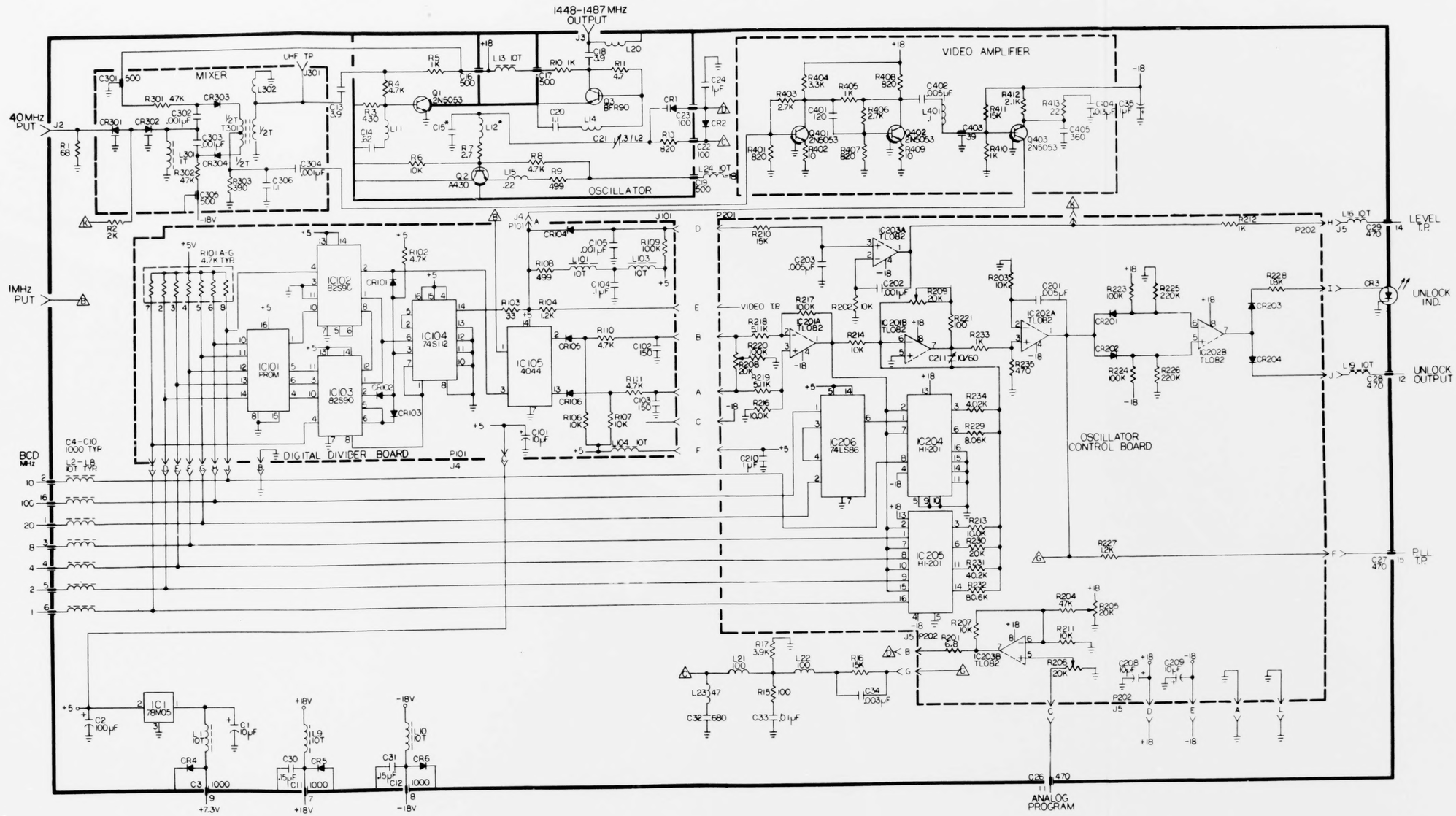
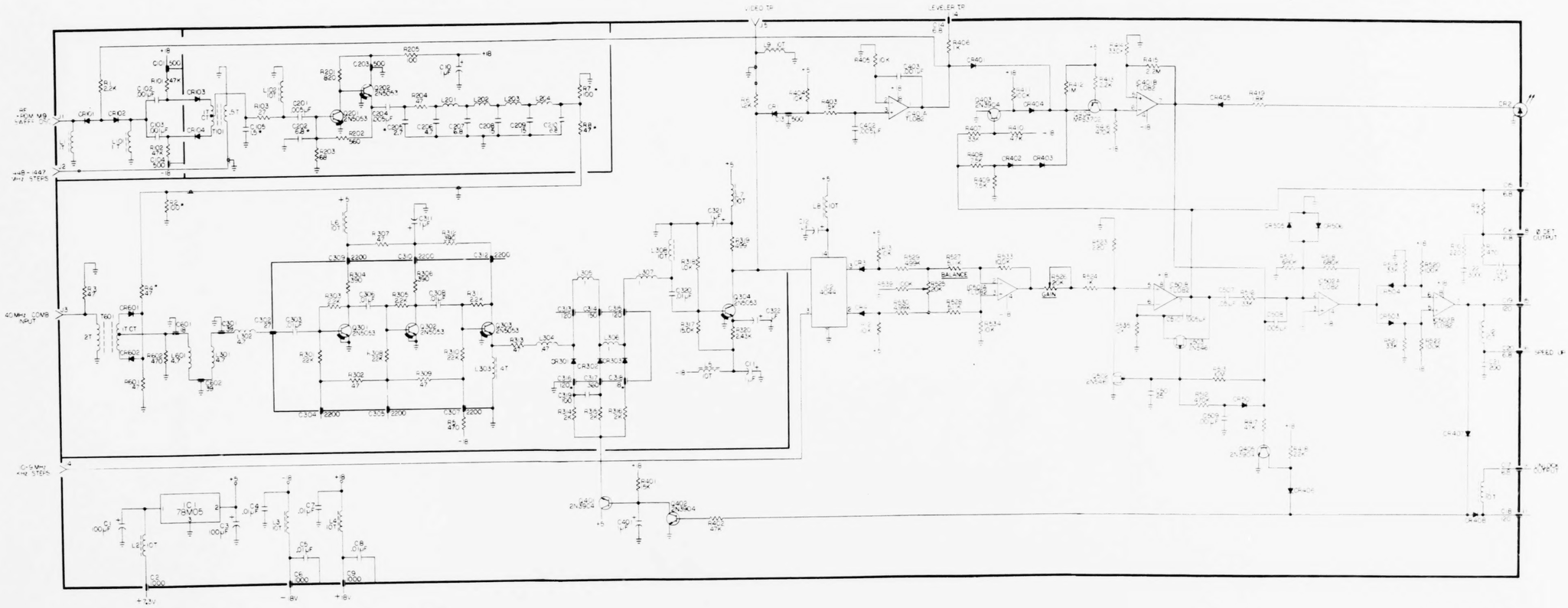


FIGURE FO-8, M172 SWEEP DRIVE/DAC



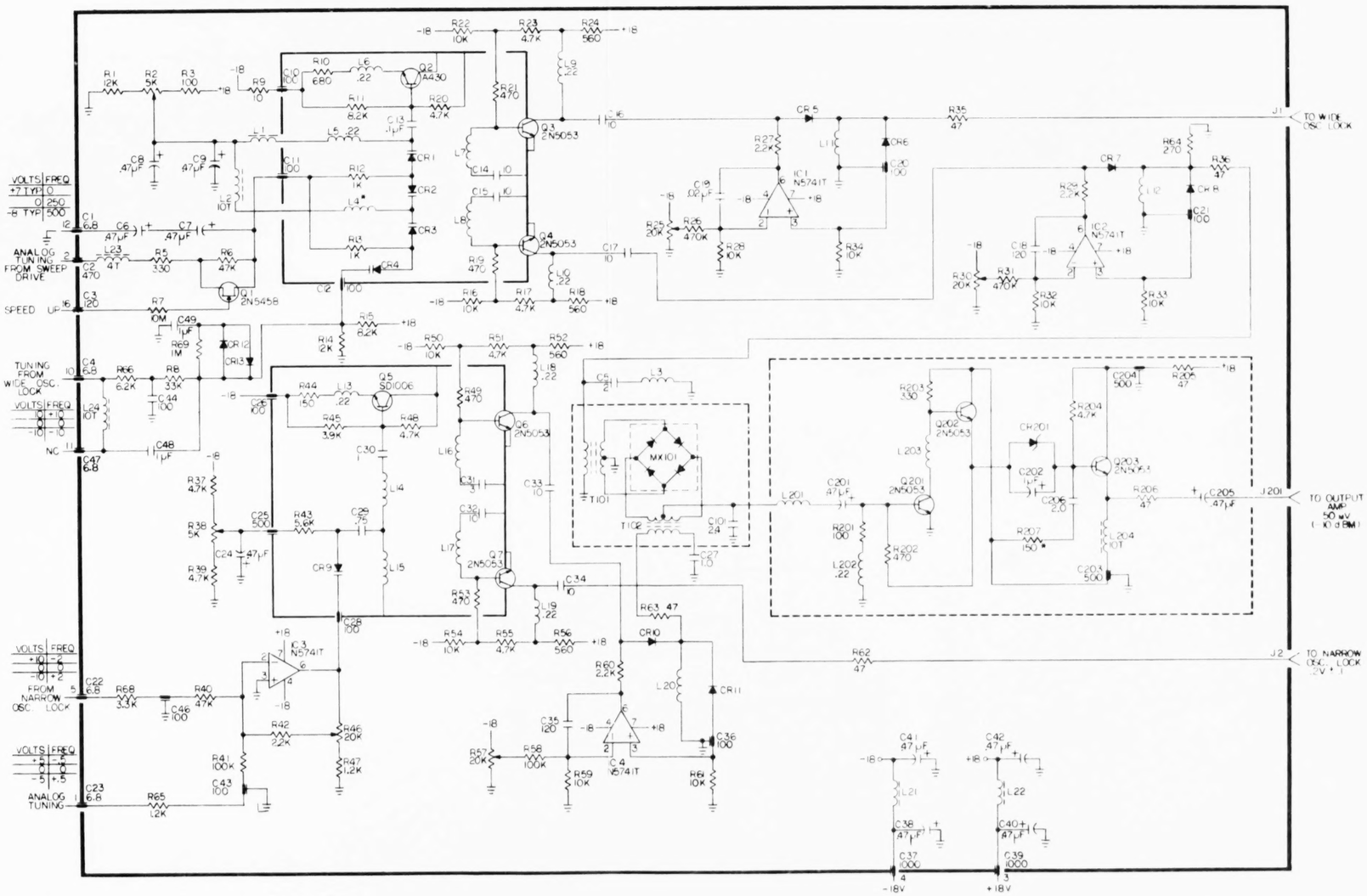
EL8NS009

FIGURE FO-9, M32A-2 1 MHz STEPS



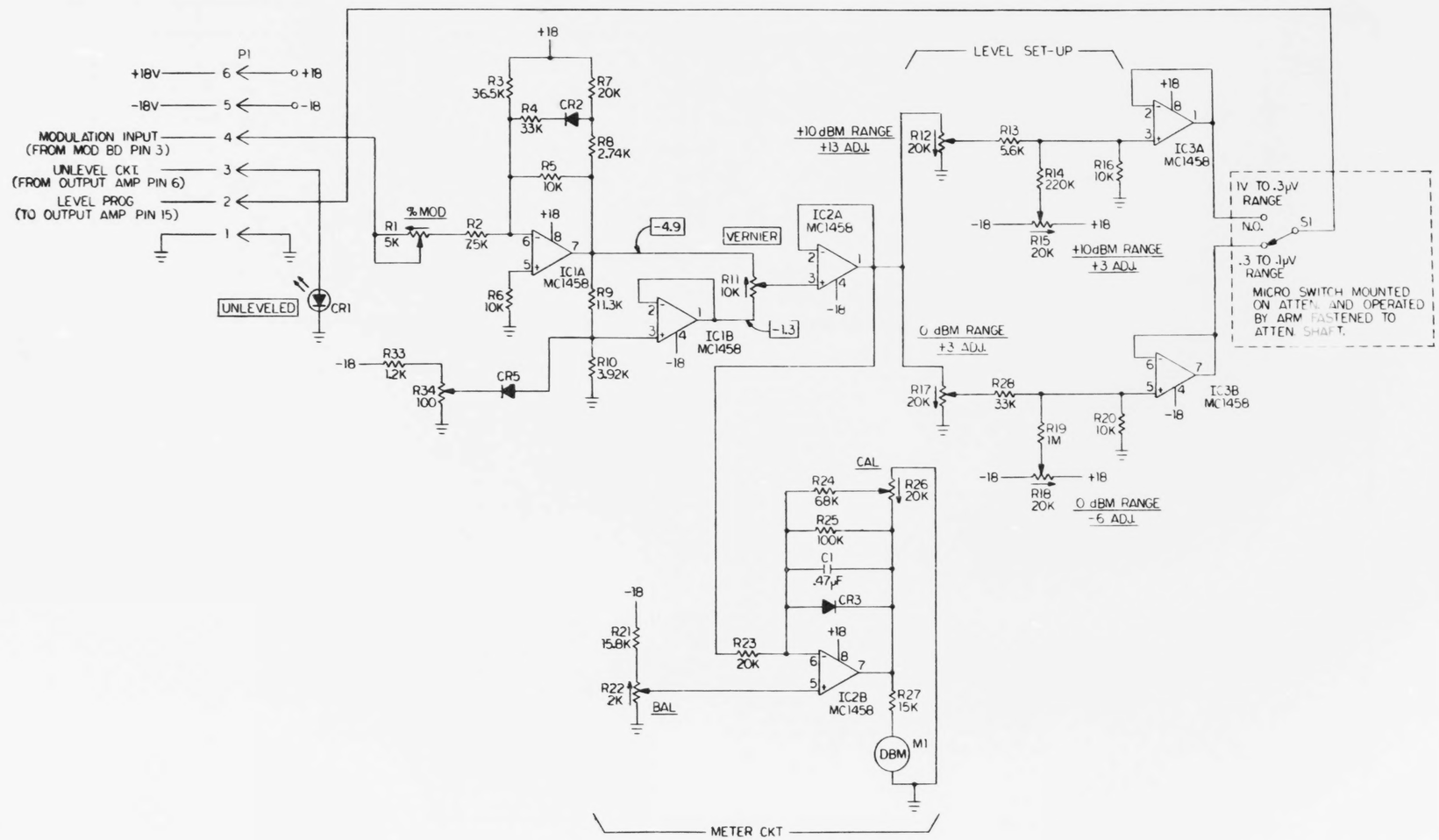
EL8NS010

FIGURE FO-10. M34-1 WIDE OSC LOCK



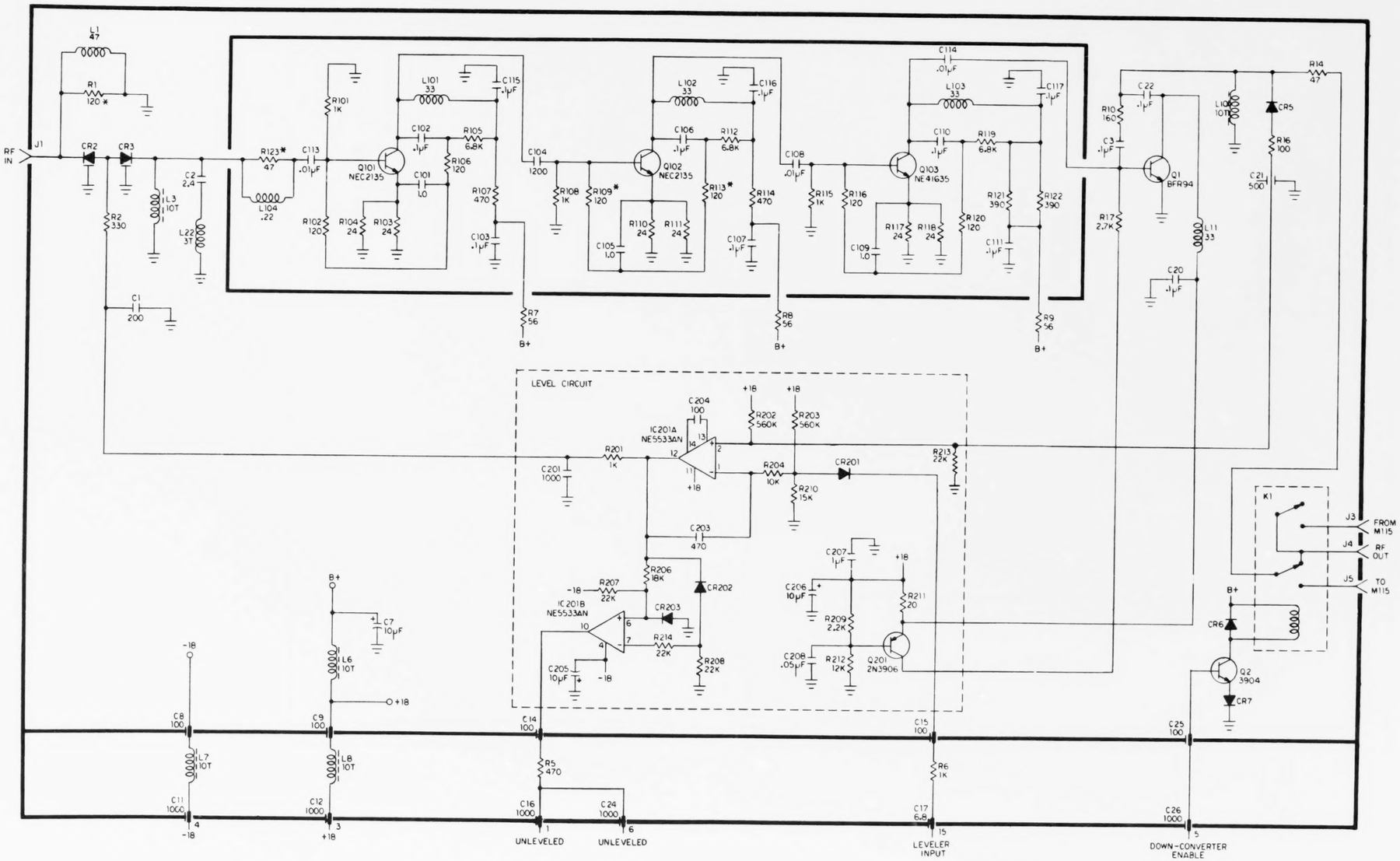
EL8NS011

FIGURE FO-11, M9W-5 SWEEP OSC



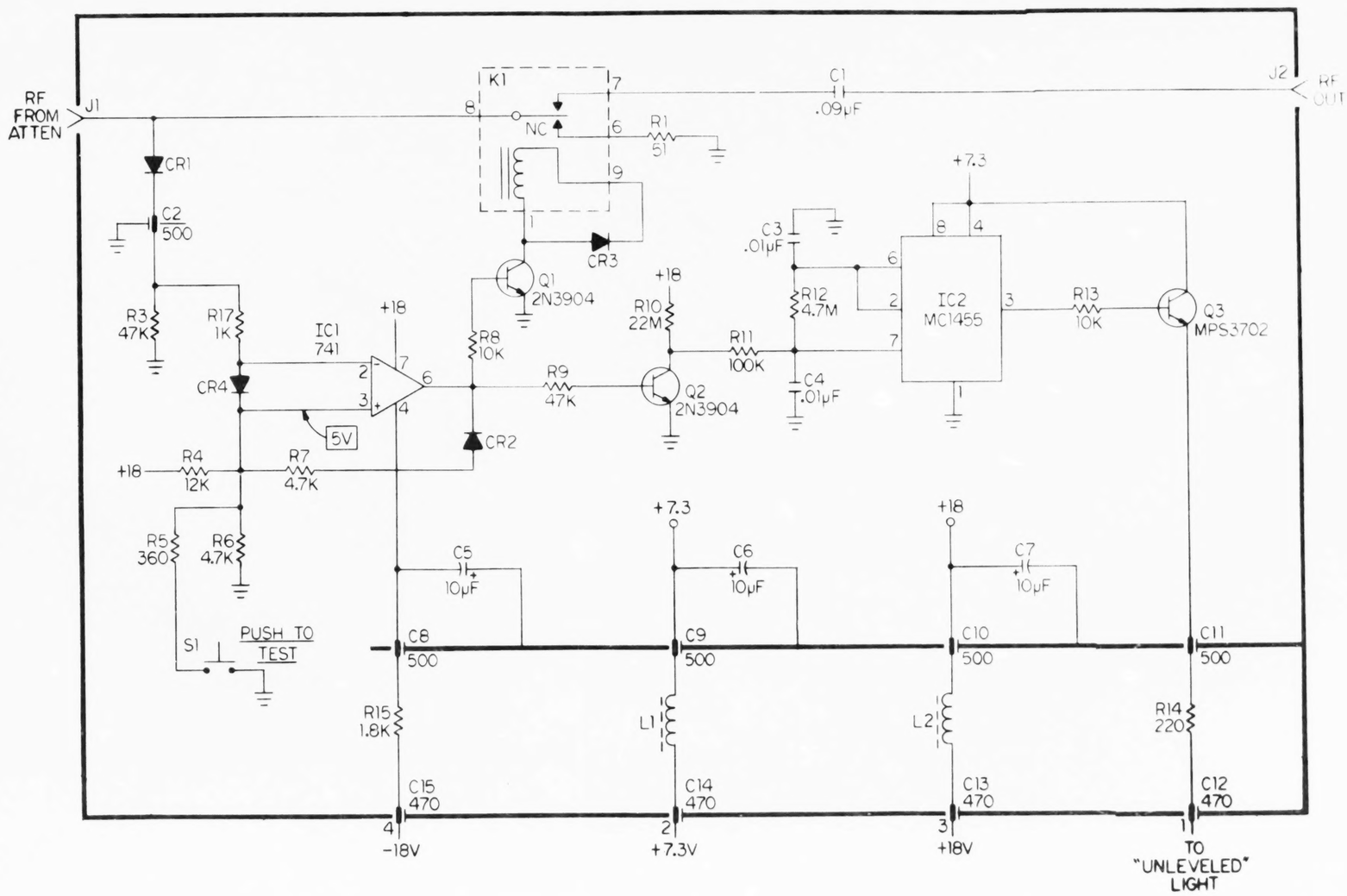
EL8NS012

FIGURE FO-12, C315 METER BOARD



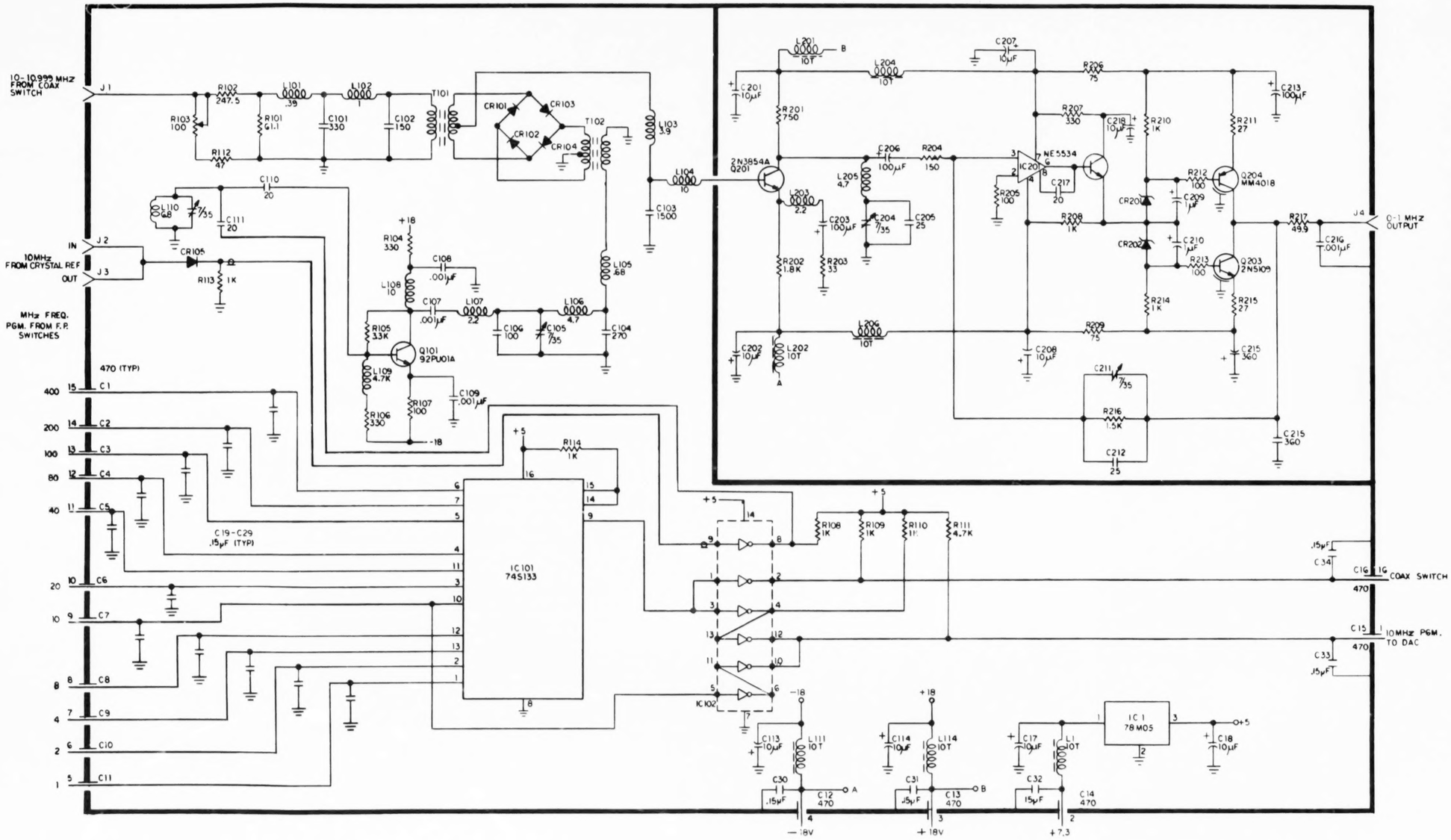
EL8NS013

FIGURE FO-13, M10W-10 OUTPUT AMP



EL8NS014

FIGURE FO-14, M35-1 RF CKT BKR



EL8NS015

FIGURE FO-15, M115 DOWN CONVERTER